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# Application of Differentiation and Universal Design for Learning in the Second Grade Science Curriculum

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APPLICATION OF DIFFERENTIATION AND  
UNIVERSAL DESIGN FOR LEARNING  
IN THE SECOND GRADE SCIENCE CURRICULUM

by

Tami Wootton Flach

A Research Project Presented in Partial Fulfillment  
of the Requirement for the Degree  
Master of Education

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## ABSTRACT

### Application of differentiation and Universal Design for Learning in the Second Grade Science Curriculum

Differentiated instruction (DI) and Universal Design for Learning (UDL) are philosophies that serve as teaching methodologies that address the needs of diverse learners in the regular classroom. Furthermore, DI can be used to engage students in instruction through different modalities, appeal to different interests, and use varied rates of instruction along with varied degrees of complexity. Also, UDL is an extension of DI, wherein the teacher provides alternatives that are built into the curriculum and suitable for most students. Additionally, the UDL model can be supported by the six principles of effective curriculum (Kame'emui & Simmons, 1999) to design curricular materials to attend to the needs of diverse learners in the regular classroom.

This project, a curriculum guide for science instruction in the second grade, addresses the needs of diverse learners in the regular classroom through DI and UDL methodologies and the six principles of effective curriculum design. Also, these units are planned in accordance with the Poudre School District (PSD) Science Standards for Grade 2. In addition, this guide may serve as a template for future lesson planning in other subject areas.

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## Chapter 1

### INTRODUCTION

Currently, teachers encounter a more diverse student population than ever before (Bowe, 2000). Many students have learning disabilities (LD) including attention deficit disorders (ADD). Some students require assistive technologies for physical limitations such as speech and language disorders or health impairments. Furthermore, Bowe stated, “Large numbers of students come from cultural traditions other than Euro-American, Judeo-Christian Western white culture and for this reason bring different expectations to the classroom” (p. 1). Furthermore, gifted and talented students, who once had special learning needs met through special classes, are now served almost entirely through regular heterogeneous classrooms (Tomlinson, 2004). As a result of this diversity, currently, teachers must rely heavily on methods to differentiate curricular materials in order to accommodate the diverse needs of learners.

### Background of Problem

The demographics of the general education classroom in the United States have changed in the last several decades. According to the authors of the 24th Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act (IDEA; 2002, as cited in National Center for Learning Disabilities [NCLD], 2006), currently, nearly 2.9 million students receive special education services for LD in the U.S. Moreover, the percentage of students with LD who spend more than 80% of their instructional time in general education has more than doubled, from 21- 45% since 1992.

According to Shin and Bruno (2003), the population of students aged 5 and over who spoke a language other than English at home in the year 2000 increased 25% since 1980. Furthermore, minority groups, taken as a whole, will increase in size until they comprise one-half of the U.S. (U.S. Department of Labor, 1999, as cited in Bowe, 2000). Also, teachers must now balance state mandated, standards based reform (Johnson, 2000) with federal mandates which require that all students meet their state academic achievement standards (Johnson; Salazar, Falkenberg, Nullman, Silio, & Nevin, 2006). As a result, teachers must meet more complex state and federal mandates while they instruct a more heterogeneous population.

#### Statement of Problem

According to IDEA (1997, as cited in NCLD, 2006), it is required that students with LD have access to the general education curriculum. In the No Child Left Behind Act (NCLB; 2002, as cited in Salazar et al., 2006), it is mandated that 100% of students demonstrate adequate yearly progress. However, often, the commercial curricula used by teachers are insufficient to instruct diverse students in the regular classroom (Baker & Zigmond, 1990; Simmons, Fuchs, & Fuchs, 1991). Frequently, teachers in the general education classrooms have to modify curriculum to reach all their students, including students: (a) with physical, emotional, or cognitive disabilities; (b) with different learning styles (LS); (c) who are identified as gifted and talented (G/T); and (d) who are English Language Learners (ELL). According to Hitchcock, Meyer, Rose, and Jackson (2002a), the general curricula available to teachers are inflexible because only those who



can hold the textbook and see and decode text can understand the concepts. Therefore, there is a need for teachers to modify curricular materials to meet the needs of diverse learners.

### Purpose of Project

The purpose of this project was to design curricular materials for science instruction to meet the needs of a diverse student population in the second grade, based on differentiated instruction (DI) and the Universal Design for Learning (UDL) model. The use of DI strategies helps teachers modify general curricular materials to meet the needs of special populations of students. The UDL is a component of DI, wherein the teacher provides alternatives that are built into the curriculum and suitable for most students. The author of this project demonstrates how DI and UDL are based upon several aspects of learning theories and supported by research. The UDL model can be used to incorporate the six principles of effective curriculum (Kame'emui & Simmons, 1999). Therefore, the UDL model is appropriate for the adjustment of standard curricular materials.

### Chapter Summary

It is important that teachers learn to accommodate diverse student populations. Since, often, general education curricula are insufficient to address the needs of all learners (Baker & Zigmond, 1990; Simmons et al., 1991), it is beneficial for regular classroom teachers to learn how to adjust curricula for the benefit of all students in order to meet state and federal mandates. In order to establish a solid foundation whereby a new curriculum may be created, in Chapter 2, the literature on: (a) learning theories, (b)

teaching diverse student populations, (c) effective curricular design, and (d) UDL literature is reviewed. In Chapter 3, Method, the procedures for the development of a curriculum based upon DI and the UDL model are detailed.

## Chapter 2

### REVIEW OF LITERATURE

The purpose of this project was to design curricular materials in order to meet the needs of diverse learners based on differentiated instruction (DI) and the Universal Design for Learning (UDL) model. Lewis and Doorlag (2003) reported that there are many methods available for teachers to adapt instruction for diverse learners. In this literature review, relevant learning theories are examined. Also, DI will be shown as theoretically sound, and verified by empirical research, as an efficient means to modify general curricula. Furthermore, an extension of DI, UDL can be used to integrate the six principles of effective curriculum (Kame'enui & Simmons, 1999) in order to adapt general curricula materials to meet the needs of nearly all learners.

#### Learning Theories

Perhaps as far back as 1897, the theoretical basis for DI began. That is when Dewey's (1897, as cited in Smith, 2001) article, *My Pedagogic Creed*, was first published. In this profound four page testimony, Dewey declared:

I believe that all education proceeds by the participation of the individual in the social consciousness of the race. . . . I believe that the only true education comes through the stimulation of the child's powers by the demands of the social situations in which he finds himself. . . . I believe that this educational process has two sides – one psychological and one sociological; and that neither can be subordinated to the other or neglected without evil results following. . . . I believe, therefore, in the so-called expressive or constructive activities as the center of correlation. . . . I believe that the only through the continual and sympathetic observation of childhood's interests can the adult enter into the child's life and see what it is ready for, and upon what material it could work most readily and fruitfully. (pp. 1-8)

DI is based upon many theories including ideas conceptualized by Dewey and those developed later: (a) Zone of Proximal Development (ZPD; Vygotsky, 1986); (b) Intelligence Theories (Gardner, 1983; Sternberg, Torff, & Grigorenko, 1998); (c) Learning Styles (LS; Dunn & Dunn, 1992, 1993; Dunn, Dunn, & Perrin 1994; both cited in Dunn, 1999); and Brain Based Learning (BBL; Jensen 1998, 2000). These theories have provided a framework upon which many of the researchers and educators cited in this literature review have conducted their studies.

### *Zone of Proximal Development*

Throughout the literature reviewed, one theory frequently referred to by researchers was Vygotsky's (1986) ZPD. Berger (2005) defined ZPD as "a range of skills that the person can perform with assistance but cannot quite perform independently" (p. 221). According to Berger, Vygotsky was the first to investigate how children learn in a social context and how children master skills are dependent upon the scaffolding provided by more experienced individuals during learning situations. Furthermore, Hitchcock, Meyer, Rose, and Jackson (2002b) stated, "Of course, the ZPD is different for different students, and teachers can lower the bar without compromising the goal by supporting students in areas of need that are not germane to the challenge at hand" (p. 13). Thus, diverse learners can coexist in the regular classroom with the proper instructional support.

### *Intelligence Theories*

Theories on intelligence have evolved from the standard Intelligence Quotient (IQ) developed by Simon and Binet in the early 20th Century (Gardner, 1983; Sternberg,

et al., 1998). Some developmentalists have argued that IQ tests cannot be used to accurately measure a person's intellectual potential (Berger, 2005). Moreover, according to Gardner (Gardner, 1983; Torff & Gardner, 1999; both cited in Berger), there are eight distinctive intelligences: (a) linguistic, (b) logical-mathematical, (c) musical, (d) spatial, (e) bodily-kinesthetic, (f) interpersonal, (g) intrapersonal, and (h) naturalistic. Similarly, Sternberg (1985; Sternberg et al.) described three distinct types of intelligence (e.g., triarchic theory): (a) academic, measured by IQ and achievement tests; (b) creative, measured by imaginative endeavors; and (c) practical, measured by everyday interactions. Also, these theories have served as instructional models in the regular classroom.

### *Multiple Intelligences*

According to Noble (2004), MI (Gardner, 1983, as cited in Noble), theory is recognized as a useful framework for teachers to identify students' different strengths as well as the different ways in which they learn. The positive effects of the MI model have been noted by several researchers (Cialdella, Herlin, & Hoefler, 2002; George, Mitofsky, & Peter, 2001; Ozdemir, Guneyasu, & Tekkaya, 2006; Schirduan & Case, 2004).

According to Schirduan and Case, primarily, the focus of the traditional curriculum of public schools is on the linguistic and logical-mathematical components of MI, while students with Attention Deficit Hyperactivity Disorder (ADHD) have been found to demonstrate naturalist and spatial intelligences as their dominate MI. Schirduan and Case found that elementary students with ADHD, who attended schools with a MI curriculum, scored significantly ( $p < .01$ ) higher on the Piers Harris Children's Self-Concept Scale (Piers, 1984, as cited in Schirduan & Case) and felt more positive toward

academic tasks than students with ADHD who attended schools without a MI curriculum. Schirduan and Case suggested that use of the MI curriculum provided ways to personalize education for students with ADHD who may find it difficult to succeed with general curricular materials.

Furthermore, several researchers (Cialdella, Herlin, & Hoefler, 2002; George, Mitofsky, & Pete, 2001; Ozdemir, Guneyasu, & Tekkaya, 2006) found that effects of the use of MI methods increased interest and achievement among elementary students. George et al. found that the implementation of diverse MI activities increased the interest and academic achievement of first and fourth grade students in social studies. Similarly, Cialdella et al. found that the use of MI increased students' motivation for learning. Cialdella et al. noted an overall improvement in grades at the primary and intermediate levels in schools in low socioeconomic areas in Illinois. The findings indicated an increase in positive behavior and parental involvement at the primary level. However, at the intermediate level, Cialdella et al. found: (a) a decrease in acceptable behavior, (b) little parental involvement, and (c) an increase in the number of missing assignments. Cialdella et al. suggested that, possibly, the older students were not used to the academic freedom of the approach; hence, MI should be incorporated at a younger age in anticipation that the younger students would be more receptive as they proceeded through middle school. In another study, Ozdemir et al. found that fourth grade students scored better on science tests when they had been taught with the use of MI methods. The students who participated in MI lessons scored significantly better ( $p < .05$ ) than the control group on a unit posttest. Additionally, the MI participants scored significantly ( $p < .05$ ) better than the control group when tested 7 weeks after the MI treatment.

Therefore, there seems to be sufficient empirical evidence to support MI as an adequate instructional model.

### *Triarchic Intelligences*

Similar to MI, Sternberg (1985; Sternberg et al., 1998) described the triarchic theory as a student's academic, creative, and practical intelligences. In two separate studies, Sternberg et al. found that students in primary and middle grades who received triarchic instruction learned more than students who received traditional memory based or analytically based instruction. They emphasized that the use of other theories (e.g., Gardner, 1983) might result in enhanced achievement as well. Sternberg et al. stated, "We believe that there is a strong need for teaching to all abilities and then assessment based on such broad teaching" (p. 15). Thus, intelligence is viewed in multidimensional ways in the current literature.

### *Learning Styles*

According to Cassidy (2004), there has been much confusion in regard to the terms: (a) learning styles (LS), (b) cognitive styles, and (c) learning strategies. Cassidy described 23 different LS models that are used currently in education. For the purpose of this review, LS theory is defined, according to Dunn and Dunn (1992, 1993) and Dunn, Dunn, and Perrin (1994, both cited in Dunn, 1999), as "the way each person begins to concentrate on, process, internalize, and retain new and difficult academic information" (p. 11). Like intelligence theories, LS theory may be utilized as an instructional model. The Dunn's Learning Style Model (1978, as cited in Dunn & Dunn) consists of five strands of 21 elements that affect each individual's capacity to learn: (a) the environmental strand refers to how individuals respond to light sound, temperature, and

seating arrangement; (b) the emotional strand refers to an individual's motivation, persistence, responsibility, and structure; (c) the sociological strand represents how individuals learn in association with peers (e.g., alone, peer groups, or authority figure); (d) the physiological strand refers to how students best perceive information (e.g., auditory, visual, tactile, and kinesthetic), time of day energy levels (e.g., early bird or night owl), and mobility (e.g., standing up vs. sitting down); and (e) the psychological strand refers to how students process information (e.g., impulsive, reflective). Therefore, teachers who adopt a LS model will: (a) adapt the classroom environment, (b) use flexible grouping, (c) vary instructional strategies and materials, and (d) modify standard curriculum to meet the unique needs of students.

Moreover, Lister's (2005) findings supported the use for LS instruction. First, Lister found a significant difference ( $p < .05$ ) in how middle school Learning Support Students (LSS) scored on the LSI (Dunn, Dunn, & Price, 2000; as cited in Lister) in comparison to average and above average students. She found that LSS students were: (a) less motivated; (b) less persistent; (c) less responsible (i.e., conforming); and, (d) yet wanted more supervision by authority figures than the other students. Second, Lister found the LSS students performed significantly ( $p < .05$ ) better on classroom tests after the receipt of LS treatments than they did with traditional treatments. Finally, a one sample  $t$  test indicated that the LSS students had more positive attitudes toward LS instructional treatments ( $p < .05$ ). Based on this research, the Dunn Learning Style Model (1978, as cited in Dunn & Dunn) had a positive effect on the achievement and attitudes of diverse learners.



On a broader scale, Kritsonis (1997/1998, as cited in Lovelace, 2005) found that the Dunn and Dunn Learning style Model (1993, 1999; as cited in Lovelace) had a notable positive influence on student success rates. Lovelace quantitatively synthesized experimental research conducted between 1980-2000. Her meta-analysis of 76 research studies included 7,196 participants which provided 168 individual effect sizes. In addition, Lovelace found the use of LS instruction increased a student's achievement and/or improved the student's attitudes. Based on the Rosenthal and Rubin (1982, as cited in Lovelace) Effect Size Display, Lovelace found a significant ( $r \approx .40$ ) mean effect size value for LS treatments. Therefore, students who are exposed to LS methods have an expected 40% success rate over students who are exposed to only traditional methods. Clearly, there is a basis for instruction to be adapted to a learner's needs.

### *Brain Based Learning*

More recently, educators have turned to what neuroscientists have found about the brain to support teaching strategies (Jenson, 1998, 2000). Jenson identified numerous Brain Based Learning (BBL) research topics such as how: (a) socialization affects brain hormone levels, (b) music influences the brain positively, (c) movement influences learning positively, (d) enrichment activities influence the brain function positively, (e) threat and stress affect memory negatively, (f) feedback plays a positive role in learning, (g) nutrition can optimize learning, and (h) memories are encoded and retrieved. According to Jenson, many BBL researchers (Brink, 1995; Greenough & Anderson, 1991; Hannaford, 1995; Houston, 1982; Miller & Melamed, 1989; Silverman, 1993; Simmons, 1995; all cited in Jensen) have supported the use of enriched environments where teachers utilize many instructional strategies such as: (a) computers, (b) field trips,

(c) guest speakers, (d) exercise, (e) pairings, (f) games, (g) journaling, and (h) multiage projects. Similar to Vygotsky's ZPD (1986, as cited in Berger, 2005), Jenson believes the use of the BBL theory supports an environment where students are challenged just beyond their comfort zone (Jenson, 1998). Additionally, challenge and feedback play an important role in learning. Jenson cautioned that what may be a challenge for one student may not be a challenge for another; thus, students should have a choice in some learning activities. Jenson (2000) warned educators on how they interpret and utilize neuroscience research; however, he stated, "Brain-Based Learning offers some direction for educators who want more purposeful, informed teaching" (p. 79).

In parallel with BBL concepts, Rose and Meyer (2002) explained that people learn through three networks of the brain: (a) recognition networks, which receive and analyze information; (b) strategic networks, which plan, organize, execute, and monitor mental and motor patterns actions and skills; and (c) affective networks, which evaluate and set priorities on an emotional level. These three networks work together to coordinate all brain activity. Rose and Meyer emphasized that, even though everyone has these same networks, individual brains differ considerably; thus, learners have individual strengths and weaknesses. Like Jenson (1993, 2000), Rose and Meyer supported the use of a variety of learning environments to address every student's unique skills.

### *Learning Theory Similarities*

To summarize learning theories, Vygotsky's (1986) theory of ZPD has been referred to often by educational researchers such as Echevarria, Vogt, and Short (1999), Hitchcock et al. (2002b), and Tomlinson (1999), as well as learning theorists such as Gardner (1983), Jensen (1998), and Sternberg (1985). Educators seem to agree that

students learn best when they are moderately challenged. Furthermore, MI, LS, and BBL have specific theoretical constructs and research bases, and when applied in the classroom, the outcomes look similar (Guild, 1997). Guild suggested that there are six areas where these theories overlap: (a) the theories are learner centered; (b) teachers are reflective practitioners and decision makers; (c) the student is a reflective practitioner; (d) the whole person is educated; (e) the curriculum has substance, depth, and quality; and (f) use of each of the theories supports diversity. Furthermore, Guild noted that the theorists encourage educators to consider other theories. Thus, educational researchers seem to agree that learning is a complex process, and students learn in various ways.

#### Teaching Diverse Learners in the Inclusive Classroom

According to Hitchcock, Meyer, Rose, and Jackson (2002a), many students were not being educated at all prior to the 1970s, because they were not permitted in school or they were present in school but not being educated. After the passage of Education for All Handicapped Children Act (Public Law 94-142; 1975, as cited in Hitchcock et al.), students with disabilities were entitled to a free and appropriate education in the least restrictive environment. Later, this law evolved into IDEA (1997, as cited in Hitchcock et al.), which entitled students to have access to the general curriculum and participate in state and district assessments with appropriate accommodations. Even though students with disabilities have the legal right to the general curricula, Baker and Zigmond (1990) and Simmons, Fuchs, and Fuchs (1991) reported that, often, the curricula itself is inadequate to meet learner needs. Additionally, Gernsten and Brengelman (1994) stated, “As cultural and linguistic diversity expands in American society, traditional educational

procedures and traditions no longer fulfill their intended purposes” (p. 3). Clearly, there seems to be a need to adjust the standard curriculum.

According to Kame’enui, Carnine, Dixon, Simmons, and Coyne (2002), instructional strategies and curriculum programs need to be flexible and robust if teachers are to have a realistic opportunity to meet the needs of all students in their classrooms. Without specific modifications, the standard curricular materials may be inadequate for students with LD and, frequently, these students find themselves blocked from access to essential aspects of the curriculum (Kame’enui & Simmons, 1999). Simmons et al. (1991), who conducted an assessment of reading curricula, concluded that, until publishers address the deficiencies of commercial programs, teachers must assume a greater role in the evaluation, selection, and redesign instructional curricula. Hence, it is the legal responsibility of educators to make the curricula available to diverse learners through two avenues: (a) DI and (b) assistive technologies (AT).

### *Differentiated Instruction*

Researchers have established that increased achievement among students occurs when teachers utilize diverse instructional strategies (Dunn & DeBello, 1999; Honigsfeld & Dunn, 1999; Lovelace & Dunn, 1999; Montgomery & Dunn, 1999; Roberts, 1999, 2001; Sceiring, 1999; Schiering & Dunn, 2001; all cited in Lister, 2005). Numerous researchers (Mayer & Gallini, 1990; Moreno & Mayer, 2002; Plass et al., 1998; Tindall-Ford, Chandler, & Sweller, 1997) have demonstrated that students learn through multiple modalities. Furthermore, Burke, Guastello, Dunn, Griggs, Beasley, and Gemake (1999/2000, as cited in Lovelace, 2005) found that instructional preferences exist and can be measured reliably. These findings support the case for DI.

According to Tomlinson (2000a), differentiated instruction is not an instructional strategy, but a philosophy about teaching and learning based on the beliefs that: (a) students who are the same age differ in their readiness to learn, their interests, their styles of learning, their experiences, and their life circumstances; (b) the differences in students are notable enough to make a major impact on what students need to learn, the pace at which to learn it, and the support they need from teachers and others to learn it well; (c) students will learn best when supportive adults push them slightly beyond where they can work without assistance; (d) students will learn best when learning opportunities are natural; (e) students are more effective learners when a sense of community is established in classrooms and schools so that students feel valued and respected; and (f) the central job of education is to maximize the capacity of each student. Tomlinson stated, “For many teachers, curriculum has become a prescribed set of academic standards, instructional pacing has become a race against a clock to cover the standards, and the sole goal of teaching has been reduced to raising student test scores on a single test” (p. 7). However, Tomlinson argued, “There is no contradiction between effective standards based instruction and differentiation. Curriculum tells teachers *what* to teach: Differentiation tells us *how*” (p. 8).

Teachers, who utilize DI, can engage students in instruction through different modalities and appeal to differing interests and use varied rates of instruction along with varied degrees of complexity (Tomlinson, 1999). According to Tomlinson (2000b), teachers can differentiate at least four elements based on student readiness, interest, or learning profile:

(a) content – what the student needs to learn or how the student will get access to the information; (b) process – activities in which the student engages in order to make sense of or master the content; (c) products – cumulating projects that ask the student to rehearse, apply, and extend what he or she has learned in a unit; and (d) learning environment – the way the classroom works and feels. (p. 2).

Villa et al. (2005) concurred with Tomlinson (1999, 2000a) and affirmed that standards based curricula can be flexible, so that different students in the same classroom can learn, practice, and demonstrate their accomplishments of a standard in different ways.

#### *Research Support for Differentiated Instruction*

Gunter, Denny, and Venn (2000), Hughes (1999), and Lou et al.(1996) provided evidence that the use of DI leads to increased academic performance among students. In a meta-analysis of within class groups, Lou et al. found instruction was most effective when instructional materials were varied. Gunter et al. concluded, in their review of literature, that the use of DI supported both the social and academic performance of students with emotional and behavioral disorders. In her action research, Hughes found that she could meet the needs of her gifted and talented students, to the students and their parents' satisfaction, in the regular classroom with DI strategies. Thus, DI practices seem to be effective among diverse populations.

In a larger study, Baumgartner, Lipowski, and Rush (2003) studied the impact of DI in second, third, and seventh grade classrooms where students were identified as low level achievers in reading. The DI strategies implemented were: (a) flexible grouping, (b) student choice on tasks, (c) increased self-selected reading time, and (d) access to a variety of reading materials. Baumgartner et al. found that after DI was implemented: (a) the number of reading comprehension strategies used by participants increased, (b) the percentage of student who could read nonsense words correctly increased, (c) the

number of students who read at targeted grade levels increased, and (d) the attitudes of students toward reading improved. These researchers noted that student choice had a positive impact on student motivation in reading. Researchers have shown that, when teachers adjust curriculum to meet the needs of diverse students, higher academic standards may be achieved (Baumgartner et al., 2003; Gunter et al., 2000; Hughes, 1999; Lou et al, 1996).

### *Assistive Technologies*

For the purpose of this literature review, assistive technologies (AT) are considered a part of DI, even though AT may include such personal devices such as: (a) wheelchairs, (b) hearing-aids, and (c) communication devices (Lewis & Doorlag, 2003). According to Lewis and Doorlag, the use of AT make the general curriculum more accessible for diverse learners. Lamm and Morissette (1994, as cited in Behrmann & Jerome, 2002) identified the areas of instruction where AT is useful for: (a) organization, (b) note taking, (c) writing, (d) academic productivity, (e) access to reference and general educational materials, and (f) cognitive assistance. The Technology Related Assistance for Individuals with Disabilities Act of 1988 (Tech Act; P. L. 100-407, as cited in Behrmann & Jerome), was designed to improve the accessibility and quality of AT. It is the responsibility of educators to consider the use of AT in the development of Individual Education Plans (IEPs) for students. AT may refer to both personal devices that provide access for disabled students as well as technology, such as computer software, that improves general curricular instruction for diverse learners.

### *Research Support for Assistive Technologies*

Several researchers (Boone & Higgins, 1993, as cited in Fitzgerald & Koury, 1996; Fasting & Lyster, 2005; Gentry, Chinn, & Moulton, 2004/2005; Higgins & Boone, 1991, as cited in Fitzgerald & Koury) have found that the use of computer AT can improve students' capabilities for learning. Fasting and Lyster, (2005) reported that the use of computer assistive reading supported basic literacy skills with a group of struggling readers and spellers in the fifth, sixth, and seventh grades. Additionally, Gentry et al. studied the effects of multimedia (e.g., computer software that incorporates animation, video, and audio) on a small group of deaf students in integrated mainstream schools. They stated, "Our findings suggest that multimedia presentation of reading material is significantly [ $p < .00001$ ] more effective for reading comprehension than is the use of print only" (p. 401). Also, Fitzgerald and Koury reported, in their extensive review of literature, that some AT enhance learning for students with disabilities. For example, a variety of AT programs for spelling have been empirically supported (Fasting & Lyster, Fitzgerald & Koury). Other researchers (Boone & Higgins, 1993; Higgins & Boone, 1991; both cited in Fitzgerald & Koury) found that the use of hypertext (e.g., computer software where the user can take greater control over the program) supplements to basal readers were beneficial in the instruction of low achieving students. Even though Fitzgerald and Koury recommended more research in the area of new technologies, they suggested that teachers introduce disabled students to technological survival skills for a changing future.

Government policies entitle students with disabilities access to the general curriculum in public schools (Johnson, 2000; Salazar, Falkenberg, Nullman, Silio, &



Nevin, 2006). Often, teachers must support the needs of diverse students, including those who are: (a) English language learners (ELL), (b) gifted and talented (G/T), (c) learning disabled (LD), (d) emotionally or behaviorally challenged and/or (e) physically handicapped students in the regular classroom. However, frequently the general curricular materials do not support diversity in the classroom; therefore, it is the teacher's responsibility to adapt materials to meet the needs of a heterogeneous group. Educators must provide AT so that all students may have access to the general curriculum. Furthermore, it is the teacher's responsibility to use DI methods, which are based on learning theories and supported by empirical research, to vary curricular materials to fit the needs of diverse learners.

#### Six Principles of Effective Curriculum Design

One question remains, "What is the best way to adjust curricula to address the needs of all learners?" According to researchers (Mann & Brandy, 1988; Stanovich, 1986, 1994; Swanson & Cooney, 1991; Torgesen 1985; all cited in Kame'enui et al., 2002), diverse students learn differently than average students in four specific areas: (a) retention of information; (b) strategy knowledge and use; (c) vocabulary knowledge; and (d) language coding, especially as it is related to early literacy development. In fact, Mann and Brandy as well as Torgesen found that diverse learners organize information differently in working memory and they retrieved long term memories differently than average achievers. These findings led researchers (Swanson & Hoskyn, 1998; Swanson, Hoskyn, & Lee, 1999; both cited in Kame'enui et al.) to conduct an extensive meta-analysis of instructional approaches that support diverse learners. These researchers identified a set of instructional principles from 180 intervention studies in which

achievement scores were positively affected. Kame'enui et al. outlined six principles of high quality educational tools based on these researchers' (Swanson & Hoskyn; Swanson, Hoskyn, & Lee; both cited in Kame'enui et al.) findings.

1. Big ideas are defined as concepts, principles, rules, or strategies that are most critical for students to learn. Big ideas should be the instructional anchors of programs for students with disabilities and diverse learning needs.
2. Conspicuous strategies are useful steps for accomplishing a goal or task. Teachers may use strategies such as visual models, graphic organizers, and clear verbal explanations.
3. Mediated scaffolding is instructional guidance provided by teachers, peers, materials, or tasks. Scaffolds are gradually removed according to learner proficiency.
4. Strategic integration is carefully sequenced instruction including introduction of a topic, scaffolding, practice and assessment. This links essential big ideas across lessons within a curriculum.
5. Primed background knowledge is the introduction of related knowledge in sequence to support the introduction of new knowledge.
6. Judicious reviews are opportunities for learners to apply and develop the new knowledge in a adequate, distributed, cumulative, and varied way.

According to the educators at the Delaware Department of Education (DDE; 2004), use of these strategies allow student to more fully participate in educational opportunities so

that all students can succeed in school. Thus, teachers can use DI in conjunction with these strategies to make the general curriculum more accessible to all learners.

### Universal Design for Learning

Educational researchers for the Center for Applied Special Technology (CAST; Hitchcock, Meyer, Rose, & Jackson, 2002a), which is part of the National Center on Accessing the General Curriculum, noted that even though policy changes such as IDEA have supported opportunities for diverse learners, they have found flaws in the overall approach to the education of students with LD. They observed that, even when curricular publishers included differentiation practices, the authors seemed to consider diverse learners as outliers and exceptions. The members of CAST considered human diversity the norm and supported curriculum that builds modifications in the curriculum, rather than curriculum that retrofits lessons to fit the needs of diverse learners. These researchers supported the UDL framework since it includes a range of options for assessment, use, and engagement with learning materials, and they recognized that no single option will work for all students (Rose & Meyer, 2002 as cited in Hitchcock et al.). In summary, the UDL curriculum provides: (a) appropriate goals for all students, (b) flexible materials, (c) flexible and diverse methods, and (d) flexible assessment.

### *Origins of Universal Design*

Over 30 years ago, Ron Mace, an architect and wheelchair user, became frustrated by the obstacles that limited his mobility in architecture and transportation (Bowe, 1999, McGuire, Scott, & Shaw, 2006). Mace and his colleagues founded the Center for Universal Design (CUD) at North Carolina State University, where he influenced

architectural designers and product developers to construct buildings and goods to reflect the needs of diverse consumers, including the young, elderly, and disabled, in mind.

According to the authors of the Assistive Technology Act (ATA; 1998 [PL 105-394], as cited in Bowe) the definition of universal design is:

a concept or philosophy for designing and delivering products and services that are usable by people with the widest possible range of functional capabilities, which include products and services that are directly usable (without requiring assistive technologies) and products and services that are made usable with assistive technologies. (p. 25).

Bowe observed that the general idea of UD is to develop features which are necessary for people with disabilities and attractive to people without disabilities, as in the development of curb-cuts. Although curb-cuts were developed to accommodate persons in wheelchairs, people who ride bikes or skateboards, walk with canes, or push strollers find them useful as well. Mace and his colleagues developed seven principles of UD: (a) The design can be used by all kinds of people, (b) the design incorporates a wide variety of preferences, (c) the product or service is easy to understand and use, (d) it works in all kinds of settings, (e) the design accommodates error, (f) the product or serve requires minimal effort to use, and (g) it accommodates variations in size and position. These seven principles of UD were adapted in the late 1990s by educators to become the basis of UDL.

### *Principles of UDL*

The UDL model is based upon UD originally intended for architecture and products. Orkwis (2003) defined UDL as “the design of instructional materials and methods that makes learning goals achievable by individuals with wide differences in their abilities” (p. 2). Also, educators in different organizations use different terms to

describe its structure. The staff of CAST described UDL in terms of multiples (Blythe, 2003; DDE, 2004; Orkwis): (a) multiple representation of content; (b) multiple means of expression, and (c) multiple options for engagement. Thus, UDL supports learning through a variety of methods and materials that provide access, challenge, and engagement for each student.

Concurrently, the staff of the University of Washington Do-It project described the philosophy of UDL with seven principles (Burgstahler, 2002, as cited in Blythe):

1. Create an *inclusive* classroom. Do not segregate or stigmatize students. Respect the privacy of students.
2. Provide *physical access* to the classroom. Make sure all doors, sinks, water fountains, and equipment are accessible by individuals with a wide range of physical abilities. Accommodate right and left handed students.
3. Alternate *delivery methods* including lecture, discussion, hands-on activities, computer work, and field trips. All these activities must be accessible to students with a wide range of abilities and interests. Speak while facing the class. Use multiple modes of delivery (i.e., verbal, visual, tactile, and kinesthetic).
4. Use assistive technologies to provide *information access*. Provide printed or electronic materials in simple, intuitive, and consistent formats. Use captioned videos.
5. Encourage various modes of *interaction*. Use flexible groupings, cooperative work, multi-age groups, reciprocal teaching etc.
6. Provide effective and prompt *feedback* during and after an activity.

7. Provide multiple ways for students to *demonstrate knowledge*. Provide alternative assessments such as projects, demonstrations, portfolios etc.

The educators at the DDE suggested that teachers should use the concepts of UDL to adjust instruction and materials for the students, rather than expect the students to adjust to the materials.

Even though members of these organizations (Burgstahler, 2002, as cited in Blythe; DDE, 2004) defined UDL with different terminology, the message seems to be clear; curriculum should be designed for maximum usability. Erlandson (2002) described UDL as a comprehensive approach to education and stated “The application of UDL principles targets the educational needs of all students while addressing different learning styles. Truly every student, from the gifted to the at-risk, to the one with physical and cognitive disabilities, benefits from UDL” (p. 2).

#### *Benefits of UDL*

Both educators (Burgstahler, 2004; DDE, 2004) and researchers (Dolan, Hall, Banerjee, Chun, & Strangman, 2005) have identified the multiple benefits of UDL. The educators at the DDE proposed the use of UDL is more effective and economical than a retrofit of the curriculum. The DDE administrators stated:

For example, time is spent more efficiently up front in developing a curriculum that is accessible by most students than by individual teachers retrofitting the curriculum for specific students on a weekly or even daily basis. The monetary cost of making inaccessible material accessible for a small percentage of students can be exorbitant. (p. 7).

Furthermore, Burgstahler of the University of Washington added that UDL benefited diverse learners who: (a) come from a variety of ethnic and racial backgrounds, (b) are ELL students; (c) have different types of learning styles; and (d) have LD (e.g., blindness

or low vision, hearing impairments, mobility impairments, psychiatric health problems, etcetera). In addition, Dolan et al. found that high school students with LD performed better on standardized history and civics tests when they were administered by a computer based system with the optional test-to-speech (CBT-TTS) based on UDL, rather than the traditional paper and pencil test (PPT) with human read aloud accommodations. Dolan et al. found a significant difference in test scores ( $p < .05$ ) when students responded to items associated with long reading passages. Although Dolan et al. considered their findings were positive, they noted that this was only a pilot study; it needs to be repeated on a larger scale. Therefore, UDL had received support from educators and pilot study researchers.

Currently, there is a lack empirical research on the effects of UDL in the regular classroom. However, there is ample evidence of the positive effects of DI in the regular classroom (Dunn & DeBello, 1999; Honigsfeld & Dunn, 1999; Lovelace & Dunn, 1999; Montgomery & Dunn, 1999; Roberts 1999, 2001; Sceiring, 1999; Schiering & Dunn, 2001; all cited in Lister, 2005). Furthermore, researchers have established the use of AT can improve students' capabilities for learning (Boone & Higgins, 1993; Higgins & Boone, 1991, both cited in Fitzgerald & Koury, 1996; Fasting & Lyster, 2005; Gentry et al., 2004/2005). The UDL model is an extension of DI. The principles of UDL directly correspond to Tomlinson's (2000b) differentiation process in the modification of: (a) content, (b) process, (c) products, and (d) learning environment. Hence, the research that supports DI appears to support UDL. Additionally, like DI, UDL follows learning theories: (a) intelligence theories (Gardner, 1993; Sternberg et al., 1998), where intelligence is viewed in multiple ways; (b) LS (Dunn & Dunn, 1992, 1993; Dunn et al.,

1994; both cited in Dunn, 1999), where educators respect how students learn and produce most effectively; and (c) BBL (Jenson, 1998, 2000), where neuroscience findings support learner differences. Even though there is a lack of empirical research to support UDL, in particular, the educators of CAST (Blythe, 2003), DDE (2004), and the Washington Do-It project (Burgstahler, 2002, as cited in Blythe) supported the UDL model and the six principles of curricular design (Kame'enui et al., 2002) to modify curriculum in order to fit the needs of all learners.

### *Cautions*

Chow, Blais, and Hemingway (1999, as cited in Jackson, Harper, & Jackson, 2001) suggested that the integration of students into the least restrictive milieu promotes: (a) self-concept, (b) social awareness, and (c) overall cognitive functioning. However, Snyder (1999) and Mercer et al. (1996, both cited in Jackson et al.) warned that inclusion is not necessarily the best approach for all students with LD. In addition, Forness, Kavale, Blum, and Lloyd (1997) and Mercer et al. (both cited in Jackson et al.) were concerned that the research which supports inclusion was outdated, and they advised further study. Nevertheless, the regular classroom teacher must leave the decision on inclusive education to policy makers and continue to practice effective instruction strategies that address the needs of diverse learners.

### *Chapter Summary*

Several learning theories have evolved since the early work of Dewey (1897, as cited in Smith, 2001). Intelligence, Learning Styles (LS), and Brain Based Learning (BBL) theories support the need for educators to modify instruction and materials to fit learner needs. Empirical research has supported Multiple Intelligences (MI) and LS as



effective curricular models. Also, Differentiated Instruction (DI) including Assistive Technologies (AT), is a teaching philosophy that emulates these theories when put into practice. Research findings supported the utilization of DI and AT. Additionally, researchers supported the need to redesign curriculum to fit the needs of diverse learners. Furthermore, the use of Universal Design for Learning (UDL) supports diverse learners by the provision of: (a) multiple representations of content, (b) multiple means of expression, and (c) multiple options for engagement. Additionally, members of the Washington Do-It project have transformed these objectives into seven principles. The UDL model is an extension of DI in theory and practice. The UDL model can be utilized to deliver the six principles of effective curriculum design, and it is supported by educators and researchers alike as a means to address the diverse needs of all learners.

The focus for this project is a handbook of second grade science curricular materials based upon DI and UDL. The handbook contains five science units supported by the six principles of effective curriculum design (Kame'enui et al., 2002). In Chapter 3, the method used to develop this curriculum is described.

## Chapter 3

### METHOD

Currently, teachers at all levels deal with a remarkably diverse student population (Bowe, 2000). Recent federal mandates require that educators provide students with LD access to the general education curriculum (Salazar, Falkenberg, Nullman, Silio, & Nevin, 2006). However, researchers (Baker & Zigmond, 1990; Simmons, Fuchs, & Fuchs, 1991) found that, often, commercial curricula use by teachers was insufficient to instruct diverse learners in the regular classroom. According to Salazar et al., differentiated instruction (DI) and Universal Design for Learning (UDL) can help educators tailor their teaching needs to meet the various strengths and needs of individual students. Furthermore, UDL provides a set of principles for teachers and administrators to design a curriculum that supports the academic success of most students. Bremer, Clapper, Hitchcock, Hall, and Kackgal (2002) recommend that the six principles of curriculum design identified by Simmons and Kame'enui (1996) as a framework to support the UDL model. The purpose of this project was to develop second grade science curricular materials, based upon DI and UDL, and supported by the six principles of effective curricular design.

### Targeted Audience

This curriculum guide is designed for application with students in Grade 2, but it should be adaptable for use in regular kindergarten and first grade classrooms. The curricular materials are suitable for diverse learners including those: (a) with physical,

emotional, or cognitive disabilities; (b) with different learning styles (LS); (c) who are identified as gifted and talented (G/T); and (d) who are English Language Learners (ELL). This curriculum guide is suitable for beginning teachers who are learning to differentiate as well as the seasoned professional who wants to try innovative practices.

### Goals

The goal of this project was to provide regular education teachers in the primary grades with supplemental science curricular materials and strategies for five curricular units suitable for teaching most students. Teachers may be able to use these curricular units as a basis to further implement their DI and UDL practices in other content areas.

### Procedure

The six principles of effective curricular design were used to develop a basic framework for five units of science instruction. According to Simmons and Kame'enui (1996, as cited in Bremer et al., 2002), the key features are:

1. Big ideas of curricula emphasize major concepts, principles, categories, rules, techniques, and hierarchical structures related to critical ideas and themes.
2. Conspicuous strategies of curricula include explicit instruction on steps to complete required tasks.
3. Mediated scaffolding of curricula includes questioning, feedback, and prompts.
4. Strategic integration amalgamates big ideas with and across curricula.
5. Judicious review links previously taught content with applications of lessons.

6. Primed background knowledge links students' previous knowledge to new information and ideas.

DI and UDL were utilized to modify general curricular materials to suit the needs of diverse learners. Tomlinson (2000b) stated DI can be used to modify curriculum (a) content, (b) process, (c) products, and (d) the learning environment. The staff of CAST (Blythe, 2003; Delaware Department of Education [DDE], 2004; Orkwis, 2003) agreed that UDL can be utilized to provide (a) multiple representations of content, (b) multiple means of expression, and (c) multiple options of engagement. Furthermore, UDL helps educators modify curriculum in such a way that teachers do not have to retrofit curriculum to suit the needs of special populations such as LD, ELL, and G/T (DDE, 2004). Also, the Poudre School District Standards (PSD, 2005) were utilized extensively as a foundation for daily lesson plans within the unit. Therefore, these units are based on local guidelines in accordance with federal policies to make the general curriculum available to all learners in the regular classroom.

#### Peer Assessment

Assessment of this curriculum was obtained from four educators, who reviewed the unit and provided informal feedback. This feedback was be used to make needed changes to the curricula. Their feedback received is discussed in Chapter 5.

#### Chapter Summary

Teachers must now balance state mandated, standards based reform (Johnson, 2000) with federal mandates which require that all students meet their state academic achievement standards (Johnson, 2000; Salazar, et al., 2006). The purpose of this project was to create a science curriculum guide for second grade teachers that will help them

meet the needs of diverse learners. This curriculum guide outlines five units, based upon DI and UDL practices and supported by the six principles of effective curriculum (Simmons & Kame'enui, 1996, as cited in Bremer et al., 2002).

This curriculum guide is not meant to replace any current curriculum or Full Option Science System (FOSS) kit; however it is intended to enhance instruction for diverse learners in the regular classroom, as well as meet the needs of the average learner. Since this guide does not address all the PSD Essential Science Standards, teachers are encouraged to supplement this curriculum with FOSS kits and/or other related materials as well as extensions to the presented curricular material. The units may be spaced out over the course of the year, and it is best to present the units in the order given, as the information presented is strategically integrated. Each unit begins with a plan based upon the six principles of effective curriculum design. Also, each Unit Plan includes a description of the unit length, PSD standards addressed during the unit, and assessment. Furthermore, each daily lesson plan (DLP) includes the (a) amount of time for lesson, (b) benchmarks addressed, (c) standards addressed, (d) pre assessment, (e) lesson instructions, (f) independent practice, (g) lesson closure, (h) post assessment, (i) how DI is utilized in the lesson and (j) how UDL is utilized in the lesson. The science curriculum guide is presented in Chapter 4.

## Chapter 4

### RESULTS

#### Introduction

This curricular guide for second grade science instruction is designed to meet the needs of diverse learners as well as average learners in the regular classroom. The units are designed based upon differentiated instruction (DI) and Universal Design for Learning (UDL) and supported by the six principles of effective curriculum (Simmons & Kame'enui, 1996, as cited in Bremer et al., 2002). The units are planned in accordance with the Poudre School District (PSD) Science Standards for Grade 2. This guide is not meant to replace any current curriculum, but to enhance the curriculum to be more accommodating for diverse learners. Furthermore, this guide may serve as a template for future lesson planning in other subjects.

This curriculum guide begins with a brief introduction about the significance of DI and UDL. Furthermore, the six principles of effective curriculum design are explained. This handbook outlines five units, based upon DI and UDL practices and supported by the six principles of effective curriculum (Simmons & Kame'enui, 1996, as cited in Bremer et al., 2002). Also, each Unit Plan will describe the unit length, PSD standards addressed during the unit, and assessment. Furthermore, each daily lesson plan (DLP) includes the (a) amount of time for lesson, (b) benchmarks addressed, (c) standards addressed, (d) pre assessment, (e) lesson instructions, (f) independent practice, (g) lesson closure, (h) post assessment, (i) how DI is utilized in the lesson and (j) how

UDL is utilized in the lesson. A list of teacher resources follows the units and the blackline masters for all units are found in Appendix B. Furthermore, rubrics for assessments may be found in Appendix C. As other teachers use this handbook, it is hoped they will expand the ideas of DI and UDL further.

DIFFERENTIATION AND UNIVERSAL DESIGN FOR LEARNING:  
SCIENCE CURRICULUM GUIDE FOR SECOND GRADE

Introduction

Currently, teachers encounter a more diverse student population than ever before (Bowe, 2000). Many students have learning disabilities (LD), including attention deficit disorders (ADD). Some students require assistive technologies for physical limitations such as speech and language disorders or health impairments. Also, the student population from diverse cultural and linguistic backgrounds is steadily increasing. The needs of gifted and talented students also need to be met in the regular classroom. As a result of this diversity, currently, teachers must rely heavily on methods to differentiate curricular materials in order to accommodate the diverse needs of learners.

The purpose of this curriculum guide is to define differentiated instruction (DI) and Universal Design for Learning (UDL) and demonstrate how the UDL model can be used to incorporate the six principles of effective curriculum design (Kame'enui & Simmons, 1999). This guide contains five example units based upon DI, UDL, and the six principles of effective curriculum design. The units are planned in accordance with Poudre School District (PSD) Science Standards for Grade 2, although they may be modified to accommodate kindergarten through first grade curriculum standards. These lesson plans may also overlap other content areas such as reading, writing, and math, although this is not a guide for integrated content. This guide is not meant to replace any current curriculum or Full Options Science System (FOSS) kit, but to enhance the



curriculum to be more accommodating for diverse learners. Furthermore, this guide may serve as a template for future lesson planning in other subjects.

### What is Differentiated Instruction and Universal Design for Learning?

Differentiated Instruction (DI) is a teaching philosophy and methodology based on the beliefs that: (a) students who are the same age differ in their readiness to learn, their interests, their styles of learning, their experiences, and their life circumstances; (b) the differences in students are notable enough to make a major impact on what students need to learn, the pace at which to learn it, and the support they need from teachers and others to learn it well; (c) students will learn best when supportive adults push them slightly beyond where they can work without assistance; (d) students will learn best when learning opportunities are natural; (e) students are more effective learners when a sense of community is established in classrooms and schools so that students feel valued and respected; and (f) the central job of education is to maximize the capacity of each student. Teachers can differentiate content, process, products, and learning environments based on student readiness, interest, and/or profile. Thus, teachers who utilize DI can engage students in instruction through different modalities and appeal to differing interests and use varied rates of instruction along with varied degrees of complexity.

The Universal Design for Learning (UDL) model is an extension of DI whereby lesson plans include variations of content, process, and/or products so that differentiation is either not needed or reduced. Educational researchers for the Center for Applied Special Technology (CAST) which is part of the National Center on Accessing the General Curriculum noted that, even though policy changes such as IDEA have supported opportunities for diverse learners, they have found flaws in the overall

approach for such students. They observed that, even when curricular publishers included differentiation practices, the authors seemed to consider diverse learners as outliers and exceptions. The members of CAST considered human diversity the norm and supported curriculum that builds modifications in the curriculum, rather than curriculum that retrofits lessons to fit the needs of diverse learners. In summary, the UDL curriculum provides: (a) appropriate goals for all students, (b) flexible materials, (c) flexible and diverse methods, and (d) flexible assessment.

### Six Principles of Effective Curriculum Design

Furthermore, UDL practices may be combined to deliver the six principles of effective curriculum design developed by Kame'enui and Simmons (1999). Kame'enui and Simmons outlined six principles of high quality educational tools based on an extensive meta-analysis of instructional approaches that support diverse learners (Swanson & Hoskyn; Swanson, Hoskyn, & Lee; both cited in Kame'enui, Carnine, Dixon, & Simmons, 2002):

1. *Big ideas* are defined as concepts, principles, rules, or strategies that are most critical for student to learn. Big ideas should be the instructional anchors of programs for student with disabilities and diverse learning needs.
2. *Conspicuous strategies* are useful steps for accomplishing a goal or task. Teachers may use strategies such as visual models, graphic organizers, and clear verbal explanations.

3. *Mediated scaffolding* is instructional guidance provided by teachers, peers, materials, or tasks. Scaffolds are gradually removed according to learner proficiency.
4. *Strategic integration* is carefully sequenced instruction including introduction of a topic, scaffolding, practice and assessment. This links essential big ideas across lessons within a curriculum.
5. *Primed background knowledge* is the introduction of related knowledge in sequence to support the introduction of new knowledge.
6. *Judicious reviews* are opportunities for learners to apply and develop the new knowledge in an adequate, distributed, cumulative, and varied way.

Educators agree that the use of these strategies allow student to more fully participate in educational opportunities so that all students can succeed in school. Thus, teachers can use DI and UDL in conjunction with these strategies to make the general curriculum more accessible to all learners.

### The Six Principles in Science Instruction

The six principles of effective curriculum design have been noted as effective when applied to science curriculum. Key components in science that also serve as a “big ideas” in the science education of younger students are the ability to identify a pattern in observations, and controlling variables based on a hypothesis. The principle of designing conspicuous strategies need not compete with inquiry (i.e. nonexplicit) based learning. It is beneficial for teachers make the *strategies* for investigations implicit, while keeping the activities student centered, after providing necessary scaffolds to support the learners participating in the activity. In order to provide strategic integration, teachers should

present lessons so that new information provides a concept for previous understandings the same way primed background knowledge supports a new lesson. Finally, since science may be a difficult subject for many, review is essential. Reviewing the big ideas in science helps younger students identify patterns and make predictions in new investigations.

### Samples of Units

Five units of study are presented in this guide to show how DI and UDL are used to modify curriculum to be suited for the needs of diverse learners. The first mini unit, “What is Science” helps teachers identify what types of science experiences the students have had. While the unit/lesson does not cover a specific benchmark, it is beneficial that the teacher provide connection with what the students have previously done in science with what the overall big idea of science is. This lesson can also provide valuable time for the teacher to model behavior expectations for the science centers and special equipment. All five units begin with an overall Unit Plan which describes the unit length, PSD standards, and assessment. The six principles of effective curriculum design serve as a unit template. The Unit Plan is followed by the necessary Daily Lesson Plans (DLP).

### *Unit Plan 1*

Title: What is Science? (Mini Unit)

Grade Level: 2, may be modified for K-2

Amount of Time: 1 lesson, 45-60 minutes

Standards:

All standards will refer to second grade standards.

PSD Essential Science Standard 1-Students will understand the processes of scientific investigation.

Big Ideas:

What is science and what do scientists do? What makes a first-rate scientist?

Scientists observe “stuff” and ask questions.

Conspicuous Strategies:

Teacher will open discussion with class with the question, “What did you do in science last year?” Teacher will show pictures and books.

Mediated Scaffolding:

Teacher will support discussion to lead to key concepts, (a) scientists observe, investigate, and explain and (b) scientists ask questions (i.e. form hypothesis).

Strategic Integration:

Correlate what students have done in previous science class to what they will do in science this year. The ideas presented in this lesson will support all scientific observations for the year.

Primed Background Knowledge:

See above.

Judicious Review:

Teacher will ask students in other lessons, “What do scientists do?”

Assessment:

Compare first journal entry “What does a scientist do?” to picture and writing titled “I am a scientist”. Does student have better understanding of science?

*Daily Lesson Plan 1: What is Science?*

Title: DLP 1-What is Science?

Time: 45-60 minutes

Benchmark:

Student will know science is the observation, investigation, and explanation of the world around us. Scientists observe and ask questions.

Standards:

PSD Essential Science Standards:

1- Process of Scientific Investigation

Daily Materials:

Teacher-Science books or magazines such as Ranger Rick or National Geographic, projector with website <http://yahooligans.yahoo.com/content/news>

Students-pencils, daily journal, crayons, picture story paper, 9 ½ x 12 in.

Pre Assessment:

Ask students “What did you do in science last year?” Let several students respond or offer ideas as needed. This will serve as a scaffold for students who do not remember. Let students journal for 5 minutes with the prompt, “What is

science?” or “What does a scientist do?” Students may draw a picture if they wish. Have several students share their entries.

#### Teaching the Lesson:

1. Pre Assessment (above)
2. Give students 5-10 minutes to browse books (e.g. *Science* (1995) by David Rueble) and magazines such as *Ranger Rick* or *National Geographic*. Tell them these all have scientific themes.
3. Show Yahoo!igans News Website, Science and Nature slideshow by projector. Emphasize the broad array of scientific study from biology to space exploration. There are many web links from this spot that show video and sound clips related to science, if time allows.
4. If students have not yet established scientist make observations and investigate the world around them, scaffold this idea. Likewise, if students have not established scientists ask questions and conduct experiments, scaffold this idea.
5. Emphasize the *big ideas*, scientists observe the world around us and ask questions about it! Make sure students, especially English Language Learners (ELL), understand the concepts of observation, investigation, and explanation.

#### Independent Practice:

Students will title a paper “I am a scientist” with the prompts “I observe...” and “I ask” on the following lines. Model this for students and give them several examples (e.g. I observe kites, I ask how they fly; I observe boats, I ask how they float; I observe rocks, I ask if they grow; I observe apples, I ask if they are good for me to eat.) Students will draw a picture of themselves on the other half of the paper.

Closure:

Let students share their ideas. Keep these works in a binder in the science corner/center.

Post Assessment:

Evaluate “I am a scientist” work. Check for understanding of science.

Differentiated Instruction:

It will be assumed in all lessons throughout this handbook, that any student with atypical physical or cognitive abilities will have necessary assistive technology and support. Accommodations for students who need to sit close to the board or other recommendations on IEPs will always be made. This assignment may need to be adapted for diverse learners who have difficulty with fine motor skills and are unable to write and draw. Verbal explanations from such students are acceptable. The foundations of science are what are important here.

Universal Design for Learning:

Teachers present information in multiple formats including projected images, printed materials, and class discussion. Students may present assessment in multiple formats including written, illustrated, or explanation form. Students choose how much they expand on their ideas in their own journals.

*Unit Plan 2: Living and Nonliving*

Title: Living vs. Nonliving (Mini Unit)

Grade Level: 2, may be modified for K-2

Amount of Time: 2 lessons, 45-50 minutes each



Standards:

All standards will refer to second grade standards.

PSD Essential Science Standards:

- 1 Process of Scientific Investigation
- 1.1 Scientific Investigations
- 2.1 Describing and Classifying Matter
- 5.3 Basic Needs of Life
- 6.6 Energy and Life
- 14.2 Scientific Knowledge

Materials & Resources: See individual DLP for instructions.

Big Ideas:

Living things (e. g. plants and animals) and nonliving things (e. g. rocks, toys, feathers, etc.) have certain characteristic. Living and nonliving things can be classified based on these characteristics. Young scientists can classify objects by making observations and asking questions.

Conspicuous Strategies:

Teacher will establish the students are to find what is living and nonliving.

Teacher will affirm the characteristics of living and nonliving things by using charts defining living vs. nonliving and stating in written and verbal form what questions need to be asked to determine if something is living or nonliving.

Mediated Scaffolding:

Class discussion will help students understand how the living nature of objects is determined. Teacher will encourage students to share what they know and elaborate or correct misinformation as needed. Students may work together in

centers. Observation worksheet will guide students to what questions need to be asked to determine if a plant is living or nonliving.

**Strategic Integration:**

Students will be reminded that scientists observe and ask questions. Future units (e. g. 4 & 5) will integrate ideas established in this unit.

**Primed Background Knowledge:**

Teacher will ask what scientists do. Student's responses to *The Velveteen Rabbit* will help students visualize what is living and what is nonliving.

**Judicious Review:**

The second lesson applies what was discussed in the first lesson. Living vs. nonliving themes will be brought up again in units 4 and 5. Therefore review of new knowledge is adequate, distributed, cumulative and varied.

**Assessment:**

Students are assessed according to their participation in discussion and activities. Observation sheets do not necessarily need to be "correct", but the students are assessed according to how they carry out scientific inquiry (e. g. observe and ask questions), and how they apply what they have learned. Students are evaluated according to the Science: Constructed Response Rubric (Appendix C) for items in the appropriate categories.

*Daily Lesson Plan 1: Unit 1, Living vs. Nonliving*

Title: DLP 1: What does it mean to be alive?

Time: 45-50 minutes

Benchmark:

Young scientists will use the process of scientific investigation to establish what makes something living or nonliving. Students will compare objects and classify objects as living or nonliving. Students will define a living object as one that grows and requires food, water, air, shelter, and space.

Standards:

PSD Essential Science Standards:

- 1 Process of Scientific Investigation
- 1.1 Scientific Investigations
- 2.1 Describing and Classifying Matter
- 5.3 Basic Needs of Life
- 6.6 Energy and Life
- 14.2 Scientific Knowledge

Daily Materials:

Teacher: *The Velveteen Rabbit* by Margery Williams, stuffed rabbit, live fish or living animal, plastic version of the same animal

Pre Assessment:

After the story ask the students, “How is this stuffed rabbit like a real rabbit?” and “How is it different from a real rabbit?”

Teaching the Lesson:

1. Read *The Velveteen Rabbit* to students.
2. See Pre Assessment
3. Reintroduce scientists observe and ask questions. Ask young scientists to observe the living and plastic fish. Ask students to compare and contrast as before.

4. Make a chart on butcher paper, living vs. nonliving. Ask students “What the characteristics of living things and nonliving things.” Record their observations. Help them establish (i.e. scaffold) living things require food, water, shelter, air, etc. Be sure to establish living things also reproduce, grow, and give waste; this will come up again in Units 4 and 5. Nonliving things do not have the same requirements as living things.
5. Establish the big idea, we can classify living things by asking these questions, “Does it grow, does it reproduce, does it eat, etc.?” Write these questions on butcher paper to be used in the next lesson.

Independent Practice: N/A

Closure:

Ask students how they would identify or classify a living thing. Model this idea. Show students an item (e. g. book, glass of water, live bug) and ask, “Does it breathe?”

Post Assessment: See DLP 2

Differentiated Instruction: N/A

Universal Design for Learning:

This may seem like a simple lesson, but it helps establish the *big ideas* of scientific investigation that are necessary for students of all abilities to understand. Teachers present information in multiple formats including printed materials, observations, and class discussion.

Source for Lesson:

Koch, J. (2000). *Science stories: A science methods book for elementary school teachers*. Boston: Houghton Mifflin.

*Daily Lesson Plan 2: Unit 1, Living vs. Nonliving*

Title: DLP 2, Classification of Living and Nonliving

Time: 45-50 minutes

Benchmark:

Young scientists will use the process of scientific investigation to establish what makes something living or nonliving. Students will compare objects and classify objects as living or nonliving. Students will define a living object as one that grows and reproduces as well as requires food, water, air, shelter, and space.

Standards:

PSD Essential Science Standards:

- 1.1 Scientific Investigations
- 2.1 Describing and Classifying Matter
- 5.3 Basic Needs of Life
- 6.6 Energy and Life
- 14.2 Scientific Knowledge

Daily Materials:

Center 1: Assortment of living and nonliving things (e. g. feather, egg, shell, rocks, toys, stuffed animals, fruit etc.)

Center 2: Live plants and silk, dried, and/or plastic plants and flowers. Live plants on side “A”, fake plants on side “B”

Students: Observation Worksheet 2.2 (see Appendix B), pencil, clipboard

Pre Assessment:

Ask , “What makes something alive?” Review previous lesson.

Teaching the Lesson:

1. See Pre Assessment
2. Post butcher paper from previous lesson. Explain centers and model Observation Sheet 2.2. Divide class into two groups to observe centers.
3. Center 1 – Students will classify items as living and nonliving by writing the name or drawing a picture in the appropriate column. Students may touch and investigate all items in both centers.
4. Center 2 – Student will record observations about plants in A and B and decide whether and determine whether they are living or nonliving.
5. Discuss observation worksheet with students. Establish plants as living organisms and let students explain why.

Independent Practice:

Although the each student has an observation worksheet, this is a group lesson. Answers are not “right” or “wrong” but lead to discussions of *why* objects are classified as living or nonliving.

Closure:

Ask, “What did you learn about living and nonliving things?”

Post Assessment:

Assess comments to closure question. Assess observations sheets and participation in class discussion.

#### Differentiated Instruction:

This assignment may need to be adapted for diverse learners who have difficulty with fine motor skills and are unable to write and draw. Verbal explanations from such students are acceptable. For those students with a better understanding of living and nonliving things extend their experience by asking questions such as, “Why is a feather nonliving and a bird living?”.

#### Universal Design for Learning:

Teachers present information in multiple formats including printed materials, observations, kinesthetic activities, and class discussion. Students may express their observations in verbal, written word, or drawn picture formats. Students may go into as much detail as they wish with their observation worksheets, allowing for creativity.

### *Unit Plan 3: States of Matter*

Title: States of Matter

Grade Level: 2, may be modified for K-1

Amount of Time:

3 lessons: Lesson 3.2 will take 2 class periods as well as observation time

Standards:

All standards will refer to second grade standards.

PSD Essential Science Standards:

- 1.1 Predictions and Hypothesis
- 1.2 Collecting Data
- 1.4 Scientific Investigations
- 2.1 Describing and Classifying Matter
- 2.2 Predicting Change within a System

- 11.2 Water States and Forms
- 14.1 Scientific Repeatability
- 14.3 Patterns and Cycles

Materials & Resources:

1. See individual lesson plans for materials needed for each lesson.
2. Students will receive a science notebook to record their own observations.

Big Ideas:

Matter can be classified as a solid, liquid, and gas. Sometimes, matter cannot be classified easily and scientists still are searching for explanations. Water can be a solid, liquid, or gas. Young scientists can classify objects by making observations and asking questions.

Conspicuous Strategies:

The teacher will model how to use and record information in the science notebook. The Observation Sheet 3.2 will aid students in recording data. Teacher will help define new terms *experiment* and *predictions*.

Mediated Scaffolding:

Teacher will support student observations by using comments and questions to guide learning. Students will also work in groups so students that have a better grasp of science concepts may support slower learners. Books about the nature of solids, liquids, and gases will be introduced in the class library and/or during literacy instruction such as *States of Matter* by Carol Baldwin, *Solid, Liquid, or Gas?* by Sally Hewitt, *The Berenstain Bears' Science Fair* by Stan and Jan Berenstain, *Puddles* by Jonathan London, *Amazing Water* by Melvin Berger, and *I am Water* by Jean Marzollo.



### Strategic Integration:

1. Now that it has been established scientists observe and ask questions, it is time to introduce that also scientists conduct experiments and make predictions. Students continue to make observations and ask questions.
2. Record keeping has now been modeled and the students are ready for their own science notebooks! This new responsibility must still be modeled and carefully assessed. If students are not ready for notebooks modify this activity or record observations as a class.
3. The topic of solids, liquids, and gases is introduced to students *before* water states and forms even though this is not a PSD science standard. It is important to establish the characteristics of matter before introducing water states. This unit will further support the investigation of the water cycle and weather.

### Primed Background Knowledge:

Read the story *Puddles* by Jonathon London during a read aloud time and ask the questions such as:

- Where did the puddles and baby rivers come from?
- What happens to puddles over time?
- Will it take longer for this to happen to big puddles or small puddles? Why?
- What happens to wet grass?
- What happens to mud?

### Judicious Review:

Briefly ask students if the materials in these lessons are living or nonliving. The second lesson, Water and Its States, is a review and application of principles learned in the first lesson, States of Matter. In the third lesson, students will apply

knowledge to classify a new material and learn that, sometimes, scientists have trouble classifying matter. Furthermore, students will continue to use their science notebooks to record information. They should become more proficient at making observations and predictions over time.

**Assessment:**

Teacher will informally assess students' understandings of solids, liquids and gases during a class discussion. Some ideas such as a "state of matter" and "gaseous forms" are more abstract for this age group. Do not expect complete understanding from all students. Proficiency will develop as student matures. Teacher will assess Observation Sheet 3.2 and Exit Slip 3.2 (see Appendix B) according to Science Rubric.

*Daily Lesson Plan 1: Unit 3, States of Matter*

Title: DLP 1: What is Matter? Exploring Solids, Liquids, and Gases

Time: 45-60 minutes

**Benchmark:**

Students will be able to name characteristics of solids, liquids, and gases and classify objects according to states of matter.

**Standards:**

PSD Essential Science Standards:

- 1.2 Collecting Data
- 2.1 Describing and Classifying Matter
- 14.3 Patterns and Cycles

**Daily Materials:**

Each group: Bag 1-plastic bag with a block, Bag 2-plastic bag with water,

Bag 3-plastic bag blown up with air. Label each bag.

Individual Student: Science notebook, pencil

Pre Assessment:

Students will be divided into groups to observe items in each bag. Students will record their *observations*. How does it feel? How does it look? *What would happen if we open the bag?* Gather as a class to discuss what each group found.

Let students share their observations. Record observations on a class chart.

Teaching the Lesson:

1. Be prepared for messes and accidents. Science is sometimes messy.
2. See Pre Assessment. This is an inquiry based lesson, however be sure to scaffold the observation process. Make the strategy for observations conspicuous; especially, ask young scientists what happens when you open the bag. If a student identifies they are solids, liquids, and gases early on, encourage them to describe the materials.
3. Explain to students these are the three states of matter. Matter is something that takes up space and has weight.
4. Ask students “Does the block take up space?” and “Does it have weight?”  
Demonstrate using the scale to weigh the block. Do the same for the water. Do the same for the gas. Scaffold the idea gas will take up the space of its container.
5. Fill out a chart named, “Characteristics of Matter”. Let students help define the characteristics of matter.

### Characteristics of Matter

Solids	Liquids	Gases
Has shape	Has size	No definite shape
Ex. block	Ex. soda	Ex. oxygen

#### 6. Class demonstration:

Weigh a balloon without air. Weigh the balloon after it is full of air. Does gas have weight? Yes! Discuss tire pumps. If the air did not take up space and have weight, tires would go flat.

#### 7. Optional class demonstration:

Fill a clear glass with ginger ale. Add raisins to the ginger ale. What is happening to the raisins? What makes them float? Gas!

Independent Practice: N/A

Closure:

Discuss what the students have found today. Restate that matter has weight and takes up space. The three states of matter, for our purpose, are solids, liquids, and gases. (Plasma and Bose-Einstein condensate are other states of matter, but do not occur under ordinary conditions.) Establish solids have a definite shape and can hold the shape under the same conditions. Liquids have a definite size, but not shape. They take the shape of their container. Gases do not have a definite size or shape. Gases take up the size and the shape of their container.

Post Assessment:

Ask students, “What is matter?” “What are the three states of matter?” and “What are the characteristics of a solid, liquid, and gas?”

Differentiated Instruction: N/A

Universal Design for Learning:

Teachers present information in multiple formats including observations, kinesthetic activities, and class discussion. Flexible groupings allow students to learn in various social contexts. Students may express their observations in verbal, written word, or drawn picture formats.

Source of Lesson:

Koch, J. (2000). *Science stories: a science methods book for elementary school teachers*. Boston: Houghton Mifflin.

*Daily Lesson Plan 2: Unit 3, States of Matter*

Title: DLP #2, Water and Its States

Time: 2 class periods, 60-90 minutes total

Benchmark:

Student will be able to identify and describe the states (solid, liquid, gaseous) in which water can be found. Young scientist will use observation, measurement, and communication skills to describe change.

Standards:

PSD Essential Science Standards:

- 1.1 Predictions and Hypothesis
- 1.2 Collecting Data
- 1.4 Scientific Investigations

- 2.1 Describing and Classifying Matter
- 2.2 Predicting Change within a System
- 11.2 Water States and Forms
- 14.1 Scientific Repeatability
- 14.3 Patterns and Cycles

Daily Materials:

Teacher: timer, coffee cans (or other container with lids), water, markers, 2 sponges

Each Group: ice, clear plastic cups, clear plastic container of a different shape or size. Observation Sheet 3.2 (see Appendix B), clipboard

Individual Student: Exit Slip 3.2 (see Appendix B), pencil, science notebook

Pre Assessment:

1. Review previous lesson with students. Let students redefine matter, solids, liquids, and gases.
2. Ask students, “What is an experiment?” Tell the students they will be conducting experiments today. Ask students, “What is a prediction?” Tell students scientists make predictions for their experiments. It is important to define new vocabulary for diverse students, especially ELL. Make sure students understand what experiments and predictions are by the end of this lesson.

Teaching the Lesson:

1. See Pre Assessment.
2. This lesson has three experiments that can be set up during one class period, (a) Ice Cube (b) Wet Sponge, and (c) Disappearing Water. The Ice Cube experiment may be conducted by groups. Have the students record observations on the Observation Sheet 3.2. The Wet Sponge and the Disappearing Water experiments

will be set up by the teacher and the students will record information in their science notebooks. It is important to model how to use the science notebooks and record information. Data will be collected for several days for the Wet Sponge and the Disappearing Water experiments. The students will record results and complete Lesson 3.2 Exit Slip upon the completion of this lesson.

3. One student in the group can record or illustrate on Observation Sheet 3.2.

Students will record observations of ice in the cup. Guide students' observations with such questions:

- What is in the cup?
- Describe the ice. What does it look like? Feel like?
- How is ice made?
- Pour the ice into the other container of different size and shape. Is it the same? Has the shape of the ice changed? Why do you think that?
- What will happen if we leave the ice out on the desk? Why? How do you know? How long will it take?

4. Set timer for 15 minutes or longer. During this time set up the Wet Sponge Experiment and the Disappearing Water experiment. Students will record observations in their own science journal. Model how you may record the information. Label one page "Wet Sponge Experiment"; label the next page "Water Experiment." Useful headings for the notebook page may be title, observation 1, observation 2, prediction
5. Show the students 2 wet sponges. Let them feel sponges. Model how to record information in the science notebook. Students record observations. Place one sponge in a can with a lid. Place the other in a can without the lid. Have students write "Predictions" in their notebooks. What do they think will happen and why?

6. Either return to the ice cube activity or move on to the Disappearing Water Experiment. Do what works best for you and your class. Set up two cans with the same amount of water. Mark the water level outside of the can with a marker. Put a lid on one can and leave the other can open. Tell the students it is important for a scientist to only change one thing (i.e. variable) in an experiment. Let the students record observations. Students will set up notebook page the same as they did for the sponge experiment. Have them make predictions (i. e. hypothesis) and record in their notebooks. Students will record what happens to the sponges and water in both cans over the next week.
7. Complete the ice cube experiment. Student will return to groups and repeat transferring the ice cube to the other container. Another student in the group may record observations. Have each group record observations and answer questions on observation sheet for assessment.
8. Take several days to record observations of the sponge and the water. Complete notebook observations with questions:
  - What happened to the sponge in the closed can? Open can?
  - Was there a difference between the sponges?
  - What might be the difference between the open can and the closed can?
  - Was your prediction correct?
  - What happened to the water level in the closed can? Open can?
  - What is the difference? Why?
  - Was your prediction correct?
  - What if we used jars instead?
9. Have students complete Lesson 3.2 Exit Slip for assessment.
10. Ask students “What happened to the water?” Explain that water evaporates and turns into a gas that we cannot see in the classroom. This may be difficult for



some students to understand at this point. Do not expect full comprehension from all students.

**Independent Practice:**

Have students complete Lesson 3.2 Exit Slip for assessment.

**Closure:**

Close the Ice Cube experiment by discussing the observation sheet. Close the final two experiments by discussion and giving more examples, before students fill out the exit slip.

**Post Assessment:**

Assess observation sheet and exit slips as well as class participation by the science constructed response rubric.

**Differentiated Instruction:**

This assignment may need to be adapted for diverse learners who have difficulty with fine motor skills and are unable to write and draw in their science notebooks.

Verbal explanations from such students are acceptable. Consider the developmental stages of the individual student. Some students may be further along in their understanding of abstract ideas than others. Assess students according to their ability levels.

**Universal Design for Learning:**

Teachers present information in multiple formats including observations, kinesthetic activities, and class discussion. Students may express their observations in verbal, written word, or illustration formats.

Source of Lesson:

Science Netlinks. (2006). Water. Retrieved September 7, 2006 from <http://www.sciencelinks.com>.

*Daily Lesson Plan 3: States of Matter*

Title: DLP #3: Mysterious Matter

Time: 45-50 minutes

Benchmark:

Students will observe, examine, describe, and classify an object of unknown matter.

Standards:

PSD Essential Science Standards:

- 1.2 Collecting Data
- 1.4 Scientific Investigations
- 2.1 Describing and Classifying Matter

Daily Materials:

Teacher: 2 cups of cornstarch, 1 cup of water, green food coloring, bowl, chart made in previous class of what are the characteristics of solids liquids gases.

Students: science notebook, pencil

Pre Assessment:

Have students name some solids, liquids, and gases. Review what they learned about water. Ask students if the materials for today's experiment are solids, liquids, or gases.

Teaching the Lesson:

1. Read *Bartholomew and the Oobleck* by Dr. Seuss. What do they think oobleck is? Tell students they will find out what state of matter oobleck is today.
2. Ask students if they have seen the cornstarch, water, and food coloring before. How is it used? What state of matter is it?
3. Make the oobleck. **DON'T POOR OOBLECK DOWN THE DRAIN!** Students will record their observations of the oobleck. Let the students experiment with the material. Does it pour? Does it splash? Compare oobleck to the chart made in Lesson 3.1. What column does it fit? Is it a solid, liquid, or gas? Have students explain their position. Take a vote. It is okay to vote, "I don't know."
4. Explain to students that this is a suspension. Move it slowly and it acts like a liquid. Move it quickly and it acts like a solid. Explain that scientists are not sure why the oobleck acts the way it does!

Independent Practice: N/A

Closure: See Post Assessment.

Post Assessment:

Ask students what they learned about solids, liquids and gases in this unit. Can liquids change to gases or solids and vice versa when conditions such as temperature are changed? What are some examples? (e. g. raw eggs into cooked eggs, clay to pottery, water to ice, water to clouds etc.)

Differentiated Instruction: N/A

Universal Design for Learning:

This is a simple, fun lesson suitable for scientists of all ages and abilities.

Teachers present information in multiple formats including observations, kinesthetic activities, and class discussion. Students may express their observations in verbal, written word, or illustration formats.

Source of Lesson:

Koch, J. (2000). *Science stories: A science methods book for elementary school teachers*. Boston: Houghton Mifflin.

#### *Unit Plan 4: Rock Hunters*

Title: Rocks and Minerals

Grade Level: 2, may be modified for K-1

Amount of Time:

5 lessons 45-60 minutes each, fourth lesson takes about 30 minutes to set up with observations over a week.

Standards:

PSD Essential Science Standards:

- 1.2 Collecting Data
- 2.1 Describing and Classifying Matter
- 9.1 Classifying Earth Materials
- 13.1 Diverse Resources

Materials & Resources:

1. See individual lesson plans for materials needed for each lesson.
2. Teacher will send a note home explaining the Rock Hunter Unit and each student should bring in 1 or 2 rocks.
3. Keep a rock collection center in the classroom during this unit.

### Big Ideas:

Rocks are solid matter that comes from the earth. Even though they seem to “grow”, “reproduce”, and “produce waste” they do not breathe and are therefore nonliving.

### Conspicuous Strategies:

Teacher will set up a KWL chart to outline the unit. Teacher will also reintroduce charts made in previous lessons, characteristics of living vs. nonliving and characteristics of solids, liquids, and gases. Remind students part of what scientists do is observe. There will be a lot of observation in this unit.

### Mediated Scaffolding:

Teacher will support student observations by using comments and questions to guide learning. Teacher will model how to make rock measurements. Students will also work in groups so students that have a better grasp of science concepts may support slower learners. Books about the nature of solids, liquids, and gases will be introduced in the class library and/or during literacy instruction such as: *Rocks: Hard, Soft, Smooth and Rough* by Natalie M. Rosinsky, *Crystals* by Melissa Stewart, *Rocks and Minerals* by Caroline Bingham, and *Experiments with Rocks and Minerals* by Salvatore Tocci. Add other rocks and minerals books or guides if you have them.

### Strategic Integration:

Previous units, Living and Nonliving as well as Solids, Liquids, and Gases, will be reintroduced and reviewed during this unit. This unit also can be integrated with math standards related to measurement. This unit will support science

standards to be covered in later grades in relation to the rock cycle, features of the Earth's surface, and geologic processes.

**Primed Background Knowledge:**

Having students collect and bring in their own rocks will spark their interest in this unit. Creating the KWL chart will prime their background knowledge and let them share what they know about rocks.

**Judicious Review:**

Previous units, Living and Nonliving as well as Solids, Liquids, and Gases, will be reintroduced and reviewed during this unit. Students will apply what they know about solids, liquids, gases as well as living and nonliving things in order to classify rocks and minerals. Students will review what they have learned in each lesson with the KWL chart.

**Assessment:**

Students will be assessed by class participation and completion of Observation Sheet 4.2 (see Appendix B).

*Daily Lesson Plan 1: Unit 4, Rock Hunters*

Title: DLP 1, What do we know about rocks?

Time: 45 minutes

**Benchmark:**

Student will describe and classify properties of rocks. Students will explain rocks come from the earth and uses for rocks (e.g. fossils, tools, gravel, arrowheads, paperweight etc.)

Standards:

PSD Essential Science Standards:

- 1.2 Collecting Data
- 2.1 Describing and Classifying Matter
- 9.1 Classifying Earth Materials
- 13.1 Diverse Resources

Daily Materials:

Teacher: butcher paper for KWL chart, collection of rocks, *Rocks: Hard, Soft, Smooth, and Rough* by Natalie M. Rosinsky.

Pre Assessment:

1. Teacher will label a KWL chart (e. g. what we *know*, what we *want* to know, what we *learned*). Students will share what they know about rocks.
2. Let the students share what they want to learn about rocks. Add these comments to the KWL chart. Make sure “Where do rocks come from?” is on the chart. Add “What is a mineral?” and “How are rocks used?” to this chart.

Teaching the Lesson:

1. Teacher will need to send note home regarding the rock unit at least on week prior to this activity. Find a system to label rocks, so students do not get them mixed up, if necessary.
2. See Pre Assessment, KWL chart.
3. Read *Rocks: Hard, Soft, Smooth, and Rough* by Natalie M. Rosinsky.
4. Has this book answered any questions? Yes. Rocks come from the earth.  
  
Minerals are made of one material and are the basic building blocks of rocks.  
  
Rubies and diamonds are examples of minerals. Native Americans carved rocks

into sharp knives and arrowheads. Scaffold these ideas if the students do not volunteer the information.

5. There is a beautiful chart on page 21 of this book! Let this be a conspicuous strategy for the lesson. This helps classify rocks. Even though the vocabulary of kinds of rocks is not necessary at this grade level, the descriptive words from the chart are very important. Let the students share describe their rocks using descriptive words from this chart such as shiny, glassy, hard, rough, chalky, cold, soft, grainy, and crumbly. This may be integrated into writing standards for literacy if time allows.

**Independent Practice:**

Each student will describe their rock to the class using descriptive words.

Closure: Review what was learned in this lesson.

Post Assessment: See Independent Practice

**Differentiated Instruction:**

Modify assessment for those who cannot physically verbalize descriptions.

Extend this activity if time allows for progressed learners. Students advanced in literacy areas may be allowed to write more elaborative detail about rocks and minerals. Possibly have students classify rocks into categories such as quartz, calcite, amethyst etc. Have students advance with this subject based on interest level.



Universal Design for Learning:

Teachers present information in multiple formats including printed materials, observations, kinesthetic activities, and class discussion. Students may be as creative and expressive as they want in their descriptions of their rocks.

Source of Lesson: N/A

*Daily Lesson Plan 2: Unit 4, Rock Hunters*

Title: DLP # 2, Rock Hunters in Action

Time: 45 minutes

Benchmark:

Student will be able to use a simple device (e. g. paperclips, balance) to gather data. Student will describe and classify properties of rocks.

Standards:

PSD Essential Science Standards:

- 1.2 Collecting Data
- 2.1 Describing and Classifying Matter

Daily Materials:

Each Group: paper clips, balance if available, rocks

Individual Student: Observation Sheet 4. 2 (see Appendix B), pencil, rocks

Pre Assessment:

1. Ask, “What have you learned about rocks so far?”
2. Ask, “Are rocks are solids, liquids, or gases?”

3. Ask students if they remember what matter is. Remind them matter takes up space and has weight. Since the idea of matter is more abstract, do not expect students to catch onto it quickly.

Teaching the Lesson:

1. See Pre Assessment
2. Rocks are solids because they keep their shape. We will measure and weigh our rocks today.
3. Model how to complete the Observation sheet 4.2. Demonstrate how to make a paper clip chain around a rock. Model how to weigh the rocks. Students will compare their rocks to others in their group.
4. Come together as a class to discuss what the students found about their rocks.  
Are all rocks the same? How are they different?

Independent Practice:

Students will complete their own observation sheet; however they will work in pairs or groups for scaffolding purposes.

Closure:

Come together as a class to discuss what the students found about their rocks.

Are all rocks the same? How are they different?

Post Assessment:

Evaluate observation sheet for completion.

Differentiated Instruction: N/A

Universal Design for Learning:

Teachers present information in multiple formats including observations, kinesthetic activities, and class discussion. Flexible groups allows students to learn in different social contexts. Students may express their observations in verbal, written word, or drawn picture formats.

Source of Lesson:

Science Netlinks. (2006). Rock Hunters. Retrieved September 7, 2006 from <http://www.sciencelinks.com>.

*Daily Lesson Plan 3: Unit 4, Rock Hunters*

Title: DLP 3, Rock Slide Show

Time: 30-45 minutes

Benchmark: Student will describe and classify properties of rocks

Standards:

PSD Essential Science Standards:

- 1.2 Collecting Data
- 2.1 Describing and Classifying Matter
- 9.1 Classifying Earth Materials
- 13.1 Diverse Resources

Daily Materials:

Individual Student: Exit Slip for lesson 4.3 (see Appendix B), pencil

Pre Assessment:

Ask students what they have learned out rocks before working in the computer lab.

### Teaching the Lesson:

1. This lesson will take place in the computer lab. Decide if you want each student to work alone or in pairs, depending on your resources and the technical abilities of you students. Another option is to set up the web sites on the projector and view as a class.
2. Set up web site [www.sciencenetlinks.com/Esheet](http://www.sciencenetlinks.com/Esheet). Demonstrate how to use the rock slide show. Students will fill out exit sheet based on this site.
3. If time allows explore let students explore other websites such as, Rock Hounds at <http://www.fi.edu/fellows/payton/rocks/index2.html> or Geomysteries at <http://www.childrensmuseum.org/geomysteries/mysteries.html>. Allow them to explore at their own pace.
4. If resources allow, set up classroom computers at these websites as centers activities.

### Independent Practice: Exit Slip 4.3

Closure: Ask, “What did you like best about the websites?”

Post Assessment: Assess exit slips for participation in activity.

Differentiated Instruction: N/A

### Universal Design for Learning:

Students explore websites at their own pace. They control their own learning.

Digital media meets students varied needs. The alternative websites allow students to learn at an appropriate ability level.

Source of Lesson:

Science Netlinks. (2006). Rock Hunters. Retrieved September 7, 2006 from <http://www.sciencelinks.com>.

*Daily Lesson Plan 4: Unit 4, Rock Hunters*

Title: DLP 4, Rock Crystals

Time: 45-50 minutes, a week for observation

Benchmark:

Young scientists make observations and communicate the result of their investigation. Students will predict what will happen to a solution if left out to dry. Students will classify an object as living or nonliving based on observations.

Standards:

PSD Essential Science Standards:

- 1.2 Collecting Data
- 2.1 Describing and Classifying Matter
- 9.1 Classifying Earth Materials

Daily Materials:

Teacher:

Demonstration 1, Sugar Crystals – pot of very hot water, sugar, 1 jar, pencil, piece of string, paper clip, clear glass

Demonstration 2, Arctic Rock Garden – small rocks, 4 tablespoons of salt, 4 tablespoons of bluing (found with the laundry detergents in the grocery), 4 tablespoons of warm water, 1 tablespoon of ammonia, shallow pan or bowl, food coloring (optional)

Student: Observation Sheet 4.4 (see Appendix B)

### Pre Assessment:

Teacher will review states of matter with students as the demonstration takes place. See Teaching the Lesson.

### Teaching the Lesson:

1. Ask students if they think rocks are living or nonliving. The students should know rocks are nonliving, but tell them, “We will demonstrate that rocks can grow. So, are rocks alive?”

2. Set up Demonstration 1. As the demonstration is begin set up, discuss if the ingredients are solids or liquids. Review solids have a definite shape while liquids do not. Students may examine sugar crystals with a magnifying glass.

Explain the solid is poured into the liquid to form a *solution*. If you have access to a microwave, heat the water here, or arrange for someone to heat the water for you. Follow the procedure:

- Little by little, add sugar to the hot water
- When no more sugar can dissolve, stop adding sugar
- Pore water into a jar.
- Tie piece of string to pencil.
- Tie paper clip to end of string.
- Lay pencil on top of jar.
- Place jar somewhere warm.
- Let sit for one week, then pull string out of jar with pencil.
- Your end product should look like this:



3. Students will record observations and predictions on Observation Sheet 4.4.
4. Set up Demonstration 2: Again, explain the states of the materials to be used and let the students observe the salt with a magnifying glass. Follow the procedure
  - Mix together salt, bluing, and warm water until dissolved
  - Add 1 tablespoon of Ammonia and food coloring if desired.
  - Stir and pour mixture slowly of rocks in shallow pan.
  - Let sit for a week
5. Students will record observations and complete Observation Sheet 4.4.
6. Wait a week to observe the rock crystals again. Students record observations
7. Determine if the rock crystals that grow, reproduce (they seem to be making more), and give waste (as they break apart) are living or nonliving. Of course, they are nonliving, but this is a fun activity for the students as they review living and nonliving systems.

**Independent Practice:**

Each student will complete a worksheet; however the entire class will complete the lesson together.

**Closure:**

Complete Observation Sheet 4.4. See Teaching the Lesson, step 6.

**Post Assessment:**

Assess Observation Sheet 4.4 for completion.

**Differentiated Instruction: N/A**

**Universal Design for Learning:**

Teachers present information in multiple formats including printed materials, observations, kinesthetic activities, and class discussion. Flexible grouping

allows for students to learn in different social contexts. Students may be as creative and expressive as they want in their observations.

Source of Lesson: N/A

*Daily Lesson Plan 5: Unit 4, Rock Hunters*

Title: DLP 5, What did we learn?

Time: 20-30 minutes

Benchmark:

Student will describe and classify properties of rocks. Students will explain rocks come from the earth and uses for rocks (e.g. fossils, tools, gravel, arrowheads, paperweight etc.)

Standards:

PSD Essential Science Standards:

- 2.1 Describing and Classifying Matter
- 9.1 Classifying Earth Materials
- 13.1 Diverse Resources

Daily Materials:

Teacher: KWL Chart

Pre Assessment: Done in DLP 1.

Teaching the Lesson:

1. It is a good idea to complete DLP 4 and lead directly into DLP 5. This lesson wraps up the unit.
2. Reintroduce the KWL chart. Add to the “What did you learn?” column.

Independent Practice: N/A

Closure: This lesson closes the entire unit.



Post Assessment: Evaluate student responses and discussion upon Science Rubric.

Differentiated Instruction:

Student assessment will be modified for those students who are unable to communicate verbally. Their observation sheets may be evaluated for assessment. Advance students and/or students with a high interest in the rocks unit will be allowed to extend learning through more writing, drawing and/or classifying activities. Those students with a high interest should be introduced to the rock cycle.

Universal Design for Learning:

Teachers present information in multiple formats including printed materials, observations, kinesthetic activities, and class discussion.

Source of Lesson: N/A

#### *Unit Plan 5: Insects*

Title: Insects

Grade Level: 2, may be modified for K-1

Amount of Time:

5 Lessons, 45-60 minutes for each lesson (unit may take up to a month to complete because of observation of butterfly life cycle)

Standards:

All standards will refer to second grade standards.

PSD Essential Science Standards:

- 1.4 Using Data
- 5.2 Classification
- 5.3 Basic Needs of Life

- 5.4 Interactions of Living Things
- 6.1 Energy and Life
- 7.3 Life Cycles
- 8.1 Characteristics of a Species
- 8.2 Adaptations to Environmental Pressures
- 14.3 Patterns and Cycles

**Materials & Resources:**

1. See individual DLP for materials needed for each lesson.
2. Provide audio and digital text of printed materials whenever possible. For directions on finding and creating digital content, as well as information about text to speech to devices, see, UDL Toolkits: Digital Content in the Classroom at <http://www.cast.org/teachingeverystudent/toolkits>.
3. There are many printed and online materials available for an Insect Unit. This example unit only uses a small sample of these abundant resources.
4. Big Ideas:

Scientists use their observation skills to explain the world around them. Scientists use their observation skills to classify organisms. Insects, living creatures, require food and shelter to survive. Living creatures can be classified by their common characteristics.

**Conspicuous Strategies:**

Teacher will set up a KWL chart to outline the unit. Students will make models of insects to investigate the body parts. There will be many kinesthetic activities in this unit.

### Mediated Scaffolding:

Teacher will let students choose reading materials appropriate for their level as well as provide digital and audio books whenever available. Students may partner read or read independently according to their level of literary competence. Many insect books are available to support this unit such as: *Bugs! Bugs! Bugs!* by Bob Barner, *How Do Flies Walk Upside Down* by Melvin and Gilda Berger, *About Bugs* by Sheryl Scarborough, *Water Bugs* by Helen Frost, *On Beyond Bugs!* by Tish Rabe, *Insectopeida* by Douglas Florian, *What's a Bug?* by Nan Froman, *Bugs are Insects* by Anne Rockwell, *The Fabulous Insects* by Charles Neider *The Very Hungry Caterpillar* by Eric Carle, *Life Cycles: Monarch Butterfly* by David M. Schwartz, and *A Butterfly's Life* by Melissa Blackwell Burke.

### Strategic Integration:

1. Unit will begin by the introduction of the topic of living things. Teacher will reintroduce that scientists observe to explain the world around them. The ideas in this unit will serve as background knowledge for future units about cycles and living things.
2. This is a perfect unit to integrate poetry, although this example unit will not be a guide for such integration. Two suggested poetry books are *Joyful Noise: Poems for Two Voices* and *Insectopedia* by Douglas Florian.

### Primed Background Knowledge:

Students will be informed of the upcoming Insect Unit. Part of this introduction will include students selecting an appropriate level book to read in the first lesson. Teacher will introduce a KWL chart in the first lesson.

Judicious Review:

The living organisms topic will be reviewed in DLP 1. Students will apply what they have learned from their reading to building their insect model. Teacher will integrate books about insects and their life cycle into literacy and read aloud.

Ongoing observations will support almost daily review of life cycles.

Assessment: Insect models and final Insect Project. Insect Project will be graded according to Science Project Rubric (See Appendix C). How well do students integrate and synthesize what they have learned through observations?

*Daily Lesson Plan 1: Unit 5, Insects*

Title: DLP # 1: What Do We Know about Insects?

Time: 45-50 minutes

Benchmark:

Students will be able to describe insects.

Standards:

PSD Essential Science Standard:

- 1.4 Using Data
- 8.1 Characteristics of a Species

Daily Materials:

Teacher: paper for KWL chart

Four centers: If the following books are not available, supply use books for different reading levels, K-3. Each center will have multiple copies of the same book. If the following books are not available, supply books for different reading levels, K-3.

- *What's that Bug* by Julian Mulock
- *Bugs Are Insects* by Anne Rockwell

- *How Do Flies Walk Upside Down?* by Melvin and Gilda Berger (This is available as an ebook as well as printed format.)
- *On Beyond Bugs! All About Insects* by Tish Rabe

Pre Assessment:

Teacher will begin the KWL chart by asking, “What do you know about insects?”

Teaching the Lesson:

1. Previous to this lesson give students about five minutes to preview the reading materials. Student will decide what book is appropriate for their reading level.
2. Begin KWL chart by asking, “What do you know about insects?”
3. Ask, “What do you want to learn about insects?” and fill in the appropriate column on the chart.
4. Students will go to their reading center and read the book independently or with a partner. Also, have audio books available. *How Do Flies Walk Upside Down?* is available digitally, although it is at a higher reading level. Presently, it is not available in text-to-speech format.
5. Students will return to class discussion. Be sure to establish scientists know what an insect is by what it looks like. This is how scientists *classify* living things. Do not identify how many body parts or how many legs and insect has at this time. You do not need to demonstrate a model at this time; this will be covered in the next lesson.

Independent Practice: N/A

Closure: See Teaching the Lesson, 5.

Post Assessment: See next lesson.

Differentiated Instruction: N/A

### Universal Design for Learning:

This lesson exemplifies the principles of UDL. The teacher has provided books in printed, audio, and digital format. Students have the choice of learning materials. Students have the choice of working with a partner or independently. Digital media meets students varied needs. DI is not needed since accommodations are built into the lesson. Teacher has provided information by discussion and printed formats.

Source of Lesson: N/A

*Daily Lesson Plan 2: Unit 5, Insects*

Title: DLP 2, Insect Models

Time: 45-50 minutes

Benchmark:

Students will create an insect model and classify insects according their observations.

Standards:

PSD Essential Science Standards:

- 1.4 Using Data
- 5.2 Classification
- 8.1 Characteristics of a Species

Daily Materials:

A collection of materials for bug models: pipe cleaners, scissors, construction paper, google eyes, crayons, colored pencils, making pens, glue, cellophane, tissue paper, sequins, Styrofoam balls, toothpicks, modeling clay or play dough  
Individual Student: science journal and materials for model .

Use *Ranger Rick's nature scope: Incredible insects* Copycat pages 13 and 14 for enrichment activities for students who finish early and have high interest in insects.

Pre Assessment: Done in previous lesson

Teaching the Lesson:

1. Have students observe pictures of true insects in books or at websites such as <http://www.enta.vt.edu/~sharov/3dvirtual.html> or <http://www.bugbios.com/entophiles> and print out the photos.
2. Tell students they get to make a model of an insect today. Do not tell students how to make the insect. Introduce the conspicuous strategy of scientific observation. Ask students to observe their chosen insect and sketch or describe how the insect looks in their science journal. Scaffold with these questions:  
What does it look like? Does it have wings, eyes, legs, etc. and how many?  
Where are the body parts on the body? How do the parts work together? How do the parts help the insects live?
3. Model how you might make an insect. For example, say “It looks like this insect has three body parts. I think I’ll use this clay to make three body parts.” Ask open ended questions of the students as they build: What is important about this insect part? How can you make your model move like the one in the picture?
4. If some students complete the model before others, provide an optional activity, *Ranger Rick's nature scope: Incredible insects* Copycat pages 13 and 14..
5. After students have completed their models, have the students reflect on their models. Ask the questions: How is your model like/different from the actual

insect? Compare your model to the actual insect; what do you notice about the body parts? How can you improve your model to look like the picture?

6. Gather again for class discussion. Ask students how many body parts, legs, antenna etc. the insects had. Fill in the KWL chart about what they learned about insect structure. Emphasize this is how scientists *classify* insects; adult insects have three body parts, two antenna, and six legs! Define the three body parts as the head, thorax, and abdomen. You may go onto diagram parts of specific insects such as compound eyes of flies and spiracles of grasshoppers.

Independent Practice: Students build their own model.

Closure: See Teaching the Lesson, 5.

Post Assessment:

Assess model. It is okay if the model does not look exactly like the picture; however, evaluate if the student understands what the differences are and what they can do to improve the model. Have students point to the insect's head abdomen, and thorax. Check for understanding.

Differentiated Instruction:

1. Those that are unable to build models physically may use the Chicago Children's Museum website  
[http://www.childrensmuseum.org/buildabug\\_real.html](http://www.childrensmuseum.org/buildabug_real.html) if applicable.
2. Provide activities for students who complete models quickly, 5.2 Activities A and B. Advanced students and students with high interest may extend lessons by writing about insects or be introduced to more information about insects.



Universal Design for Learning:

Teacher presents information in multiple formats including printed materials, digital materials, and kinesthetic activities. Digital media meets students varied needs. Student may present understanding by drawing and making 2-D or 3-D models.

Source of Lesson:

Science Netlinks. (2006). Insect Models. Retrieved September 15, 2006 from <http://www.sciencelinks.com>.

*Daily Lesson Plan 3: Unit 5, Insects*

Title: DLP 3, The Life Cycle of Butterflies: Metamorphosis

Time: 60 minutes, up to 3-4 weeks of observations

Benchmark:

Young entomologists will recognize scientists observe the world around them to provide explanations. Students will describe what living things need for survival. Students will be able to describe the life cycle of butterflies.

Standards:

PSD Essential Science Standards:

- 5.2 Classification
- 5.3 Basic Needs of Life
- 5.4 Interactions of Living Things
- 6.1 Energy and Life
- 7.3 Life Cycles
- 8.1 Characteristics of a Species
- 14.3 Patterns and Cycles

Daily Materials:

Teacher: caterpillars can be ordered from many supply companies including

Nature Gift Store at <http://www.natrue-gifts.com>. Aquarium with mesh lid and leaves, and food source for caterpillars and butterflies according to supplier directions.

Retrieve the following from [enchantedlearning .com](http://enchantedlearning.com):

1. Blackline master of caterpillar anatomy from [enchantedlearning.com](http://enchantedlearning.com) or other source for students to glue or draw into their science notebooks.
2. Enchanted Learning has several life cycle handouts for educators to choose from. Download these blackline masters for students to glue into science notebooks. Also, enlarge these to display in the classroom as needed.
3. Life Cycle of a Butterfly decodable from [enchantedlearning.com/subjects/butterfly/books/butterflylifecycle](http://enchantedlearning.com/subjects/butterfly/books/butterflylifecycle)
4. Life Cycle assessment from [enchantedlearning.com/butterfly/label/lifecycle/label.shtml](http://enchantedlearning.com/butterfly/label/lifecycle/label.shtml)

Individual Student: science notebook for recording observations

Pre Assessment:

Reintroduce insects are living organisms. Ask “What do living things need to survive?” Inform students they will observe living caterpillars. You may wish to set up a KWL chart or informally assess students on what they know about caterpillars. The caterpillars have ten legs. Are they insects?

Teaching the Lesson:

1. See Pre Assessment

2. Students will observe caterpillars in and record observations with drawings and descriptions in their notebooks. Have them glue (or draw) blackline master of caterpillar anatomy from Enchanted Learning into their notebooks. Show students even the caterpillars have the three body parts of an insect: abdomen, thorax, and head. Even though they have 10 legs, they are insects. Student will discover why as they observe. Most students will know caterpillars will turn into butterflies. This activity emphasizes the process of the lifecycle.
3. Have students observe the caterpillars daily. Be sure to emphasize what the caterpillars need to survive. Students record observations in their notebooks.
4. During a literacy block enlarge and construct butterfly decodable from Enchanted Learning. Read the decodable as a class and partner read. Check for understanding.
5. As students complete their observations of the metamorphosis, have them color and glue sections of butterfly lifecycle into their notebooks (from Enchanted Learning). The students may not be able to observe the egg stage, so make sure they understand this part of the life cycle.
6. Go over life cycle of butterflies frequently over the course of the unit to provide judicious review. Strategically integrate many books covering the life cycles of butterflies including: *The Very Hungry Caterpillar*, by Eric Carle, *Life Cycles: Monarch Butterfly* by David M. Schwartz, and *A Butterfly's Life* by Melissa Blackwell Burke. Keep these books in library center and integrate into read aloud.

7. Introduce that other insects have similar lifecycles as the butterflies. The National Wildlife Federation has examples in *Ranger Rick's Nature Scope: Incredible Insects*, found at the Ft. Collins Library.
8. More butterfly and insect crafts and activities are available at Enchanted Learning at <http://www.enchantedlearning.com>.
9. Have students complete Life Cycle Assessment from Enchanted Learning. First see if they can complete it individually using their notebooks. Then let them gather into groups to discuss how they completed the worksheet and make needed changes.

Independent Practice:

Students will record observations in science notebooks.

Closure:

End this lesson with a summary/discussion on what they learned about butterflies.

Post Assessment:

Life Cycle Assessment. If student is unable to write, let them explain the life cycle of butterflies.

Differentiated Instruction:

Provide “sponge activities” for students who complete observations and models quickly. *Ranger Rick's nature scope* pages 13 and 14 are examples. Provide many levels of reading material in various formats in classroom library during this unit. Let students who have difficulty with kinesthetic activities demonstrate knowledge in verbal form.

Universal Design for Learning:

Teachers present information in multiple formats including observations, kinesthetic activities, and class discussion. Flexible grouping allows for students to learn in various social contexts. Students may express their observations in verbal, written word, or illustration formats.

Source of Lesson:

Enchanted Learning. (n.d.) Butterflies. Retrieved September 16, 2006 at <http://www.enchantedlearning.com>.

National Wildlife Federation. (1999). *Ranger Rick's nature scope: Incredible insects*. Philadelphia: Chelsea House.

*Daily Lesson Plan #4: Unit 5, Insects*

Title: DLP 4, Insect Habitats

Time: 45-60 minutes

Benchmark:

Student will describe insect habitats based on their needs as living organisms.

Students will describe how insects interact with their environment.

Standards:

PSD Essential Science Standards:

- 5.3 Basic Needs of Life
- 5.4 Interactions of Living Things
- 6.1 Energy and Life
- 7.3 Life Cycles
- 8.1 Characteristics of a Species
- 8.2 Adaptations to Environmental Pressures
- 14.3 Patterns and Cycles

Daily Materials:

Each student:

*Ranger Rick's nature scope: Incredible insects* Copycat pages 87-90, Land and

Water Insects

Each Group: Handout 5.4 (see appendix B) and insect books and field guides

Pre Assessment:

Ask “What is a *habitat*?” and “What do insects need to live?”

Teaching the Lesson:

1. Ask student what they need to live. Ask Pre Assessment questions.
2. Explain a *habitat* is an animal's home. An animal's home will match to what the animals needs. Ask “Where do you think water bugs live?” and “Where do grasshoppers live?” Expand on this idea.
3. Complete Copycat pages as time permits. Model how to cut out Pond and Back Yard and glue to corresponding page.
4. For Activity Sheet 5.4, divide class into groups or pairs. Use field guides and books to fill out sheet. Model how to locate an insect in a guide or book and fill out sheet. Have a member of each group share what they have learned.
5. Discuss how the insects find everything they need in their habitat. Ask, “Why do monarch butterflies lay their eggs on milkweed plants?” Monarch larvae (i. e. caterpillars) eat milkweed leaves to grow. Their habitats include grassy areas with milkweed. Ladybugs are found on plants that attract aphids. Why? Ask, “Can you think of other examples of insect habitats?”

Independent Practice: Copycat pages, Land and Water Insects

Closure: See Teaching the Lesson, 5.

Post Assessment:

Asses Activity Sheet 5.4 for completion. Assess student's comprehension of habitats. Can students come up with examples of how insects needs correspond to their habitat or do they need more examples for comprehension? Base further instruction on this assessment.

Differentiated Instruction:

Support students who need help with kinesthetic activities. Advanced students or students with high interest may extend this lesson further with more research on the internet or in printed format.

Universal Design for Learning:

Teacher provides information in discussion and kinesthetic activities. Group work scaffolds the learning process. Students express comprehension in written, kinesthetic, and illustration forms.

Source of Lesson:

National Wildlife Federation. (1999). *Ranger Rick's nature scope: Incredible insects*. Philadelphia: Chelsea House.

*Daily Lesson Plan 5: Unit 5, Insects*

Title: DLP 5: Habitats and Eating Habits

Time:

50-60 minutes, add 30 minutes of media lab time if Archibald's Adventure is done.

**Benchmark:**

Student will describe insect habitats based on their needs as living organisms.

Students will describe how insects interact with their environment.

**Standards:**

- 5.3 Basic Needs of Life
- 5.4 Interactions of Living Things
- 6.1 Energy and Life
- 7.3 Life Cycles
- 8.1 Characteristics of a Species
- 8.2 Adaptations to Environmental Pressures
- 14.3 Patterns and Cycles

**Daily Materials:**

Teacher: books and insect field guides and projector set up with these websites:

[http://www.brookview.karoo.net/Sticl\\_Insects](http://www.brookview.karoo.net/Sticl_Insects),

<http://www.thewildones.org/Animals/camo.html>, and

<http://pbs.org/wgbh/evolution/library>

A collection of materials for bug models: pipe cleaners, scissors, construction paper, google eyes, crayons, colored pencils, marking pens, glue, cellophane, tissue paper, sequins, Styrofoam balls, toothpicks, modeling clay or play dough, shoeboxes for dioramas

**Pre Assessment:**

Review what students learned in previous lesson about habitats. Can students think of examples?

**Teaching the Lesson:**

1. See Pre Assessment



2. Show images of insects from websites or find a video of insect life to show to students. The PBS.org website mentioned earlier is highly recommended. This is a one minute video clip of a camouflaged praying mantis. All these websites show how insects camouflage.
3. Ask, “How does camouflage help insects?” Camouflage helps protect insects as well as hides them from their prey. Explain how insects have *adapted* to their environment. Tell students some insects can adapt to many environments such as cockroaches. Can they think of other examples of *adaptive* insects (e. g. house flies, ants, some beetles)?
4. If there is time and resources, have students log onto Pest Worlds website at <http://www.pestworldforkids.org/archibald/index.html>. This is a suitable activity for all skill levels because it is an interactive activity with text-to-speech capabilities. The student helps Archibald the Ant rummage the house for food, provide food for the queen, so more eggs can be laid.
5. Inform parents of this activity, as it may be homework. Send a copy of the grading rubric so parents and students understand expectations. Give students adequate time to complete project. Students will create a diorama or poster of an insect of their own imagination from the provided materials or materials from home. The student will explain or demonstrate how the insect adapts to its environment. They should show how the insect eats. The student may make up a name for this insect. (Students may also choose a true insect if they want.)
6. Students will share their projects to the class.

7. Close Unit 5 with completion of KWL chart. What did students learn about insects?

Independent Practice: Project outlined in Teaching the lesson, 5.

Closure:

Close Unit 5 with completion of KWL chart. What did students learn about insects?

Post Assessment: Assess project according to Insect Project Rubric.

Differentiated Instruction:

Students will be graded according to the rubric as well as their ability level.

Students progress at different rates and have different abilities.

Universal Design for Learning:

Teachers present information in multiple formats including observations, kinesthetic activities, and class discussion. Digital media meets students varied needs. Students may express their knowledge in verbal, written word, models, or drawn picture formats according tot their interest level.

Source of Lesson: N/A

### Chapter Summary

This curricular guide for second grade science instruction is designed to meet the diverse needs of students in the regular classroom. The units are designed based upon differentiated instruction (DI) and Universal Design for Learning (UDL) and supported by the six principles of effective curriculum (Simmons & Kame'enui, 1996, as cited in Bremer et al., 2002). The units are planned in accordance with the Poudre School District (PSD) Science Standards for Grade 2. This guide contains five science units to

be taught over the course school year and should be integrated with Full Option Science Systems (FOSS) kits and other science curricular materials. A discussion of the curriculum guide is presented in Chapter 5.

## Chapter 5

### DISCUSSION

The purpose of this project was to develop a guide for second grade science instruction designed to meet the needs of diverse learners as well as average learners in the regular classroom. The units are planned in accordance with the Poudre School District (PSD) Science Standards for Grade 2 (see Appendix A). The units were designed based upon differentiated instruction (DI) and Universal Design for Learning (UDL) and supported by the six principles of effective curriculum (Simmons & Kame'enui, 1996, as cited in Bremer et al., 2002).

#### Contributions of this Project

This curriculum guide provides practical ways for the general education teacher to instruct science for diverse learners in the second grade. The guide includes multiple flexible teaching materials, diverse teaching methods, and flexible assessment when compared to traditional “one size fits all” curriculum. Furthermore, the curriculum enriches traditional Full Option Science Systems (FOSS) kits so that students get a more complete understanding of the “big ideas” of science. This enriched understanding aids the students as they progress into more complex science study. Also, this guide provides information for teachers to further expand DI and UDL ideas into other content areas. The six principles of effective curriculum alone provide teachers with tools to improve the effectiveness of traditional curricular materials for the diverse learner.

## Limitations

Even though the curriculum guide was evaluated as successful, several limitations are addressed. For example, this author encountered difficulty in acquisition of flexible digital media suitable for second grade students to use in science lessons. According to Rose and Meyer (2002), digital media are more flexible than traditional fixed media such as text, speech, and images. Furthermore, these researchers commented that digital text, sound, and images can be adjusted for different individuals and can open doors to learning. Although this author found many electronic books (ebooks) available online, it was difficult to find published ebooks appropriate for science instruction. The one book that was found for the insect unit was for a higher grade level and did not offer the text-to-speech option for delayed readers. Of course, a teacher can make their own ebook with the appropriate software; however, the time and funds needed for such a project are not always available. Many activities can be found online such as, Archibald's Adventure used in DLP 5 of Unit 5. This website exhibits the essence of UDL instruction because of the interactive nature of the website and the speech-to-text options. However, a teacher's time for location of such activities is often limited by other responsibilities. Expectantly, as interest in UDL and digital materials increase the availability of digital science curriculum materials will also increase. Furthermore, according to the educators of the Delaware Department of Education (DDE; 2004), UDL classrooms do not necessarily need to be technology based when the six principles of effective curriculum are utilized.

In addition, other limitations of this project include: (a) teachers adhering to traditional curricular materials, (b) time consuming lessons and planning, and (c)

resources for teacher training and technology. First, researchers have noted (Edwards, Carr, & Siegel, 2006) that, often, both new and veteran teachers lack the education to differentiate classroom materials to meet the needs of diverse learners or that teachers often adhere to traditional curriculum that does not effectively address the needs of diverse learners (Brener et al., 2002; Jackson, Harper, & Jackson, 2001). The educators who evaluated this curricular guide agreed that this is too often the case. Second, DI and UDL initially may take more planning time than using traditional curricular materials. Finally, schools and districts often lack the funds for staff development and technology needed to make curricula more accessible for diverse learners. Limitations in this project include difficulty accessing digital materials for science instruction as well as teacher reluctance to try differentiated instruction, lack of time, and the financial burden of UDL.

#### Peer Assessment

Four educators were consulted on the applicability, strengths, and limitations of the curriculum guide: (a) a first year teacher, (b) a 27 year veteran of both the regular and special education classroom, (c) a college instructor and primary teacher of 10 years, and (d) an elementary school principal. Overall, the feedback regarding the curriculum guide was positive. Some enrichment ideas were added to a few of the Daily Lesson Plans in the Differentiated Instruction area to address the needs of advanced or highly interested students. In general, the curriculum guide was minimally changed. Thus, this curriculum guide for science instruction, based on DI and UDL and supported by the six principles of effective curriculum, was evaluated as successful for the education of diverse students in the regular classroom and provides teachers with practical examples of DI and UDL in the classroom.

## Recommendations for Further Development

Researchers Rose and Meyer (2002) have made suggestions to overcome some of the drawbacks of implementing DI and UDL. Rose and Meyer suggested introducing UDL strategies as support for reaching goals and overcoming barriers rather than as another “great new thing” to overcome teachers’ reluctance to try DI and UDL. Additionally, Rose and Meyer emphasized that it is important for school and district administration to implement UDL methods with support of digitized materials, software tools, consultants for curriculum development, and release time for teachers to work on UDL curricula. Also, it is important that teachers collaborate on DI and UDL materials as well as team teach to lessen the burden on individual teachers. Finally, Rose and Meyer recommended teachers take the initiative in finding funding opportunities through federal grants. Furthermore, grant proposals can originate at the district level, or come from individual schools, departments (i.e. technology, special education), or groups of teachers. This researcher found that once DI and UDL resources are in place and supported by education teams, instruction and assessment become easier. It is highly recommended that teachers investigate the possibility of grants to support UDL digitized materials and computer software that are easily adapted for the use of diverse learners. With ingenuity and collaboration at the school and district level, the needs of all learners may be fulfilled.

## Project Summary

The purpose of this project was to develop a guide for second grade science instruction designed to meet the needs of diverse learners as well as average learners in the regular classroom based on DI and UDL and supported by the six effective principles

of curriculum design. Strengths of the curriculum include flexible and supportive printed, kinesthetic, digital materials for instruction and learning as well as flexible and accessible assessments. Limitations of the project include, (a) digital materials suitable for second grade curriculum were often difficult to locate, (b) lesson planning is often time consuming, and (c) lack of resources for technology and training. When teachers have the support of administrators and districts, obstacles may be overcome to provide the best education for all learners.



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## APPENDIX A

### Poudre School District Essential Science Standards

## **SCIENCE: PSD ESSENTIAL STANDARD 1: SECOND GRADE**

### **Science Process and Skills:**

**Students understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations (Colorado 1).**

#### **1.1 BENCHMARK: Predictions and Hypotheses**

**Students ask questions and stating predictions (hypotheses) that can be addressed through a scientific investigation.**

- o Given a description of an investigation, identify the question or problem statement being explored.
- o Given a description of an investigation, tell what you think will happen and why.
- o Given a situation, dilemma, or observation, identify a scientific question that could be investigated.

#### **1.2 BENCHMARK: Collecting Data**

**Students select and using simple devices to gather data related to an investigation (for example, length, volume, and mass measuring instruments, thermometers, watches, magnifiers, microscopes, calculators and computers).**

- o Identify appropriate tools for use in a given investigation such as recording temperature, length and width, volume or mass in metric units.

#### **1.3 BENCHMARK: Using Data**

**Students use data based on observations to construct a reasonable explanation.**

- o Given a simple data table or graph, select or construct a reasonable explanation based on the evidence provided.

#### **1.4 BENCHMARK: Scientific Investigations**

**Students communicate about investigations and explanations**

- o Given a scientific question, identify data that would need to be collected to answer the question.
- o Given a question and a set of data, select a graph that best displays the data.

#### **1.5 BENCHMARK: Organizing Data**

**Students use appropriate tools, technologies and measurement units to gather and organize data.**

- o *Addressed in grades 5-10.*

#### **1.6 BENCHMARK: Interpreting Data**

**Students interpret and evaluating data in order to formulate conclusions.**

- o *Addressed in grades 5-10.*

#### **1.7 BENCHMARK: Scientific Communication**

**Students communicate results of their investigations in appropriate ways (for example written reports, graphic displays, oral presentations).**

- o *Addressed in grades 5-10.*

#### **1.8 BENCHMARK: Scientific Theories**

**Students explain the differences between a scientific theory and a scientific hypothesis.**

- o *Addressed in grades 5-10.*

#### **1.9 BENCHMARK: Process of Science**

**Students explain that scientific investigations sometimes result in unexpected findings that lead to new questions and more investigations.**

- o *Addressed in grades 5-10.*

#### **1.10 BENCHMARK: Scientific Collaboration**

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Students give examples of how collaboration can be useful in solving scientific problems and sharing findings.

- o *Addressed in grades 5-10.*

#### **SCIENCE: PSD ESSENTIAL STANDARD 2: SECOND GRADE**

##### **Physical Science: Properties of Matter:**

Students know and understand common properties, forms and changes in matter and energy. (Focus: Physics and Chemistry). Students know that matter has characteristic properties, which are related to its composition and structure (Colorado 2.1).

##### **2.1 BENCHMARK: Describing and Classifying Matter**

Students examine, describe, classify, and compare tangible objects in terms of common physical properties (for example, state of matter, size, shape, texture, flexibility, color).

- o Using an illustration, classify and compare objects with common physical properties (for example, state of matter, shape, and size). *Also addressed in grade 4.*
- o Describe the properties used to classify a collection of objects (for example, state of matter, shape, size). *Also addressed in grades 3 and 4.*

##### **2.2 BENCHMARK: Measuring Physical Properties**

Students measure common physical properties of objects (for example, length, mass, volume, temperature)

- o *Addressed in grades 3 and 4.* Using an illustration, measure a physical property (for example, length, temperature).

##### **2.3 BENCHMARK: Separating Mixtures**

Students create mixtures and separating them based on differences in properties (for example, salt and sand, iron filings and soil, oil and water).

- o *Addressed in grade 4.* Suggest a possible method to separate a mixture based on differences in a physical property (for example, iron filings and soil, oil and water).

##### **2.4 BENCHMARK: Modeling matter**

Students develop simple models to explain observed properties of matter (for example, using a particle model to account for the solubility of a substance).

- o *Addressed at grades 5-10.*

#### **SCIENCE: PSD ESSENTIAL STANDARD 3: SECOND GRADE**

##### **Physical Science: Forms of Matter:**

Students know and understand common properties, forms and changes in matter and energy. (Focus: Physics and Chemistry). Students know that energy appears in different forms, and can move (be transferred) and change (be transformed) (Colorado 2.2).

##### **3.1 BENCHMARK: Effects of Energy on Matter**

Students recognize that energy (for example, light, heat, motion, sound, mechanical) can affect common objects and is involved in common events.

- o *Addressed in grades 1, 3, and 4.* Given an object, identify how a type of energy is likely to affect it (for example, light, heat, motion, sound, or mechanical).
- o *Addressed in grades 1, 3, and 4.* Given an object, describe how an energy form will affect it.

##### **3.2 BENCHMARK: Observing the Effects of Energy on Matter**

Students make observations and gather data on quantities associated with energy, movement and change (for example, distances for a bean launcher, time for a melting ice cube).

- o *Addressed in grades 1, 3, and 4.* Assess in conjunction with Standard 1.

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- 3.3 BENCHMARK: Recording the Effects of Energy on Matter**  
Students compare quantities associated with energy movement and change by constructing simple diagrams or charts (for example, graph of launch distances, chart of melting time.)
- o Addressed in grades 1, 3, and 4. Assess in conjunction with Standard 1.

**SCIENCE: PSD ESSENTIAL STANDARD 4: SECOND GRADE**

**Physical Science: Interactions of Matter and Energy:**

Students know and understand common properties, forms and changes in matter and energy. (Focus: Physics and Chemistry). Students understand that interactions can produce changes in a system, although the total quantities of matter and energy remain unchanged (Colorado 2.3).

- 4.1 BENCHMARK: Characteristics of a System**  
Students observe and describe parts of system (for example, water in a closed jar, water in an open jar, a plant terrarium).
- o Addressed in grade 3. Describe differences between diagrams of systems and predict the effects of those differences on the operation of the systems.
- 4.2 BENCHMARK: Describing Change within a System**  
Students describe an observed change, for example, a melting ice cube, crystal growth, burning candle, physical breakage, in terms of starting conditions, type of change, and ending conditions, using words, diagrams, or graphs.
- o Addressed in grades 1 and 4. Show in pictures a change involving energy transfer (for example, pushing an object).
  - o Addressed in grade 4. Using a graph, describe a change involving energy transfer.
  - o Addressed in grades 3 and 4. Describe in words a change involving energy transfer.
- 4.3 BENCHMARK: Predicting Change within a System**  
Students predict what might change and what will remain unchanged when matter experiences an external influence (for example, a push or pull, addition or removal of heat, division of clay into pieces, melting an ice cube, changing a ball of clay to a flattened shape).
- o Given a scenario involving a change due to an external influence, predict how things will change. Also addressed in grade 3.
  - o Given a scenario involving a change due to an external influence, predict quantities that will not change. Also addressed in grade 3.
- 4.4 BENCHMARK: Chemical and Physical Change**  
Students describe, measure and calculate quantities before and after a chemical or physical change within a system (for example, temperature change, mass change, or specific heat).
- o Addressed in grades 5, 6, 7, and 8.
- 4.5 BENCHMARK: Forces of Motion**  
Students describe, measure and calculate quantities that characterize moving objects and their interactions within a system (for example, force, velocity, acceleration, potential energy, kinetic energy).
- o Addressed in grades 5, 6, 7, and 8.

**SCIENCE: PSD ESSENTIAL STANDARD 5: SECOND GRADE**

**Life Science: Characteristics of Living Things:**

Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (Focus: Biology-- Anatomy, Physiology, PSD 2005

Botany, Zoology, and Ecology). Students know and understand the characteristics of living things, the diversity of life, and how living things interact with each other and with their environment (Colorado 3.1).

**5.1 BENCHMARK: Living Things**

**Students distinguish living from nonliving things.**

- o Given a list of objects, identify each as living or nonliving. *Also addressed in grades K and 1.*

**5.2 BENCHMARK: Classification**

**Students classify a variety of organisms according to selected characteristics (for example, backbone vs. no backbone).**

- o *Addressed in grades K and 1.* Sort living organisms as either plant or animal.
- o Group organisms by a physical characteristic [for example, body covering, body support (bone, shell, exoskeleton, leaf structure) insects, fish, mammal, bird]. *Also addressed in grade 3.*

**5.3 BENCHMARK: Basic Needs of Life**

**Students describe the basic needs (for example, food, water, air, shelter, space) of an organism.**

- o Name the basic needs of all animals (for example, food, water, air, shelter, space). *Also addressed in grades K and 3.*
- o Communicate examples of shelters and tell about the types of animals that might use them. *Also addressed in grades K and 3.*
- o Explain that all types of animals have the same basic needs but differ in what they use to meet those needs [for example, caterpillars eat leaves, but robins eat worms]. *Also addressed in grade 3.*
- o *Addressed in grades K and 1.* Name the basic needs of all plants (for example, light, water, air).

**5.4 BENCHMARK: Interactions of Living Things**

**Students give examples of how organisms interact with each other and with nonliving parts of their habitat.**

- o Give examples of how a particular animal uses plants and other animals in its habitat to meet its needs. *Also addressed in grade 3.*
- o Describe examples of predator-prey relationships [for example, of one animal type eating another]. *Also addressed in grade 4.*
- o Describe how plants depend on animals [for example, carry pollen or to disperse seeds]. *Also addressed in grade 1.*
- o Describe how plants and animals depend on non-living parts of their habitat. *Also addressed in grades K and 3.*

**5.5 BENCHMARK: Environmental Effects on Living Things**

**Students describe how an Environment's ability to provide food, water, space, and nutrients determines carrying capacity.**

- o *Addressed in grades 5, 6, 7, and 8.*

**SCIENCE: PSD ESSENTIAL STANDARD 6: SECOND GRADE**

**Life Science: Matter, Energy, and Living Systems:**

**Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (Focus: Biology--Anatomy, Physiology, Botany, Zoology, and Ecology). Students know and understand interrelationships of matter and energy in living systems (Colorado 3.2).**

**6.1 BENCHMARK: Energy and Life**

**Students recognize that green plants need energy from sunlight and various raw materials to live, and animals consume plants and other organisms to live.**

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- o Group animals based on the types of food they eat (for example, herbivores, carnivores, omnivores). *Also addressed in grades 3 and 4.*
- o Know that animals use food for growth as well as for energy. *Also addressed in grades 1 and 3.*
- o *Addressed in grade 3.* Describe what happens to an animal when it does not get enough food.
- o *Addressed in grades 1 and 3.* Describe what happens to a plant when it does not get its basic need of light.

**6.2 BENCHMARK: Energy Flow in Food Chains and Webs**

**Students recognize the interrelationships of organisms by tracing the flow of matter and energy in a food chain.**

- o *Addressed in grades 3 and 4.* Organize the sun, a plant, and two appropriate animals into a food chain.
- o *Addressed in grades 3 and 4.* Describe the source of food for each organism in a food chain.
- o *Addressed in grades 3 and 4.* Predict what would happen if one organism were removed from a food chain.

**6.3 BENCHMARK: Energy Requirements of the Cell**

**Students describe ways (for example, digestion, transport of nutrients by circulatory system) that multi-cellular organisms get food and other matter to their cells.**

- o *Addressed in grades 5, 6, 7, and 8.*

**6.4 BENCHMARK: Energy Cycles in Living Systems**

**Students explain the recycling of materials by determining a pathway of a substance that is important for life (for example, trace water through an ecosystem).**

- o *Addressed in grades 5, 6, 7, and 8.*

**6.5 BENCHMARK: Decomposition in Living Systems**

**Students describe the role of organisms in the decomposition and recycling of dead organisms (for example, bacteria's role in the decomposition and recycling of matter from a dead animal).**

- o *Addressed in grades 5, 6, 7, and 8.*

**SCIENCE: PSD ESSENTIAL STANDARD 7: SECOND GRADE**

**Life Science: Structure and Function of the Body:**

**Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (Focus: Biology--Anatomy, Physiology, Botany, Zoology, and Ecology). Students know and understand how the human body functions, factors that influence its structures and functions, and how these structures and functions compare with those of other organisms (Colorado 3.3).**

**7.1 BENCHMARK: Human body Systems**

**Students describe human body systems (for example, digestive, respiratory, circulatory, skeletal, muscular).**

- o *Addressed in grades 1 and 4.* Identify the senses.
- o *Addressed in grades 1 and 4.* Describe each sense (for example, touch tells us about size, shape, texture).
- o *Addressed in grade 4.* Recognize that the human body is composed of systems.
- o *Addressed in grade 4.* Given a model or diagram, locate the body systems.
- o *Addressed in grade 4.* Describe the main functions of human body systems (skeletal system provides protection and support, muscular system allows us to move, and digestive system allows us to meet our need for food and water).

**7.2 BENCHMARK: Nutritional Requirements**

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**Students describe the basic food requirements for humans as summarized in the current nutrition pyramid.**

- o Describing the basic food requirements for humans as summarized in the nutrition pyramid.
- o Using the current nutritional guidelines, describe the basic food requirements for humans.
- o Give a description of a healthy meal and classify the foods into their food groups.
- o Name examples of foods that are high in sugar but low in important nutrients.
- o Identify that the foods we eat come from carbohydrates, fats, and/or proteins.
- o Identify foods that are likely to be high in fat.
- o Identify foods that are likely to be good sources of fiber.

**7.3 BENCHMARK: Life Cycles**

**Students describe life cycles of selected organisms (for example, frog, chicken, butterfly, radish, bean plant).**

- o Explain what is meant by the term life cycle (for example, a plant starts from a seed and produces seeds to start new plants, human's stages of life) and understand that similar organisms go through similar life stages. *Also addressed in grades 1, 3, and 4.*
- o *Addressed in grades 1 and 3.* Observe and draw several types of seeds.
- o *Addressed in grades K, 1, and 3.* Sequence pictures that show stages in the growth of a plant from a seed and describe changes that take place as a plant grows.
- o Describe the stages of an insect's life cycle (for example, egg, larva, pupa, adult).

**7.4 BENCHMARK: Structures and Functions of Body Systems**

**Students describe the structures and functions of human body systems.**

- o *Addressed in grades 5, 6, 7, and 8.*

**7.5 BENCHMARK: Disease**

**Students describe and give examples of non-communicable diseases and communicable diseases (for example, heart disease, chicken pox).**

- o *Addressed in grades 5, 6, 7, and 8.*

**7.6 BENCHMARK: Reproduction and Development**

**Students describe the pattern and process of reproduction and development in several organisms (for example earthworm, chick, human).**

- o *Addressed in grades 5, 6, 7, and 8*

**SCIENCE: PSD ESSENTIAL STANDARD 8: SECOND GRADE**

**Life Science: Evolution and Genetics:**

**Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (Focus: Biology-- Anatomy, Physiology, Botany, Zoology, and Ecology). Students know and understand how organisms change over time in terms of biological evolution and genetics (Colorado 3.4).**

**8.1 BENCHMARK: Characteristics of a Species**

**Students identify characteristics that are common to all individuals of a species (for example offspring resemble their parents).**

- o List characteristics that are common to all animals of a specific kind (for example, offspring resemble parents). *Also addressed in grades K and 3.*
- o Identify the adult insects in a group based on characteristics (for example, 6 legs, 3 body sections, and two antennae.).
- o *Addressed in grades K, 1, and 3.* Observe and draw a plant, labeling roots, leaves, and stem.
- o *Addressed in grades K, 1, and 3.* List characteristics that are common to plants of the same kind (for example, offspring resemble parent).

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- 8.2 BENCHMARK: Populations**  
**Students recognizing that there are differences in appearance among individuals of the same population or group.**
- o *Addressed in grades K, 1, and 3.* Observe and describe ways that plants or animals of the same population and life stage look different.
- 8.3 BENCHMARK: Adaptations to Environmental Pressures**  
**Students identify characteristics of plants and animals that allow them to live in specific environments.**
- o Identify modifications animals have in order to eat certain foods (for example, match types of teeth with types of food). *Also addressed in grade 3*
  - o *Addressed in grades K and 3.* Identify modifications plants have in order to survive (for example, a desert cactus has spines and a waxy coat).
- 8.4 BENCHMARK: Extinction**  
**Students describe examples of extinct organisms based on fossil evidence (for example, dinosaurs).**
- o *Addressed in grade 4.* Identify fossils as the reason we know that dinosaurs ever existed.
  - o *Addressed in grade 4.* Tell why an animal may go extinct.
  - o *Addressed in grade 1.* Distinguish between extinct and imaginary animals (for example, dinosaurs and dragons).
- 8.5 BENCHMARK: Population Variety and Survival**  
**Students explain why variation within a population improves the chances that the species will survive under new environmental conditions.**
- o *Addressed in grades 9 and 10.*
- 8.6 BENCHMARK: DNA and Protein Synthesis**  
**Students describe the general structure and function of the gene (DNA) and its role in heredity and protein synthesis (for example, replication of DNA, the role of RNA in protein synthesis).**
- o *Addressed in grades 9 and 10.*
- 8.7 BENCHMARK: Heredity and Probability**  
**Students calculate the probability that an individual will inherit a particular single gene trait (for example, calculate the probability of offspring inheriting cystic fibrosis when both parents are carriers).**
- o *Addressed in grades 9 and 10.*

## **SCIENCE: PSD ESSENTIAL STANDARD 9: SECOND GRADE**

### **Earth and Space Science: Geologic Products and Processes:**

**Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. Students know and understand the composition of Earth, its history, and the natural processes that shape it (Colorado 4.1).**

- 9.1 BENCHMARK: Classifying Earth Materials**  
**Students describe different types and uses of Earth materials (for example, rocks, soil, minerals).**
- o Identify rocks and soils and where they are found. *Also addressed in grade 4.*
  - o Describe rocks and soils using properties (for example, color, size, shape, and texture). *Also addressed in grade 4.*
  - o *Addressed in grade 4.* Describe ways we use earth materials in everyday life.

### **9.2 BENCHMARK: Fossils**

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**Students recognize that fossils are evidence of past life.**

- o *Addressed in grade 4.* Identify a fossil as a once-living plant or animal (for example, leaf, shell, bone).
- o *Addressed in grade 4.* Explain that fossils are found in rocks.

**9.3 BENCHMARK: Features of the Earth's Surface**

**Students identify major features of Earth's surface (for example, mountains, rivers, plains, hills, oceans, plateaus).**

- o *Addressed in grade 4.* Identify surface features from pictures (for example, mountains, rivers, plains, oceans, plateaus).

**9.4 BENCHMARK: Geologic Processes**

**Students describe natural processes that change Earth's surface (for example, weathering, erosion, mountain building, volcanic activity).**

- o Distinguish between weathering and erosion. *Also addressed in grade 4.*
- o *Addressed in grade 5.* Describe two processes that cause rocks to weather (for example, freeze/thaw cycles, wind, rain).
- o *Addressed in grade 5.* Describe two ways that rocks and sand are eroded (for example, water, wind).
- o *Addressed in grade 5.* Explain how features on the Earth's surface (for example, canyons, valleys, sand dunes, sandbars) are formed by erosion and deposition.

**9.5 BENCHMARK: Effects of Geology**

**Students recognize that humans are affected by natural events (for example, earthquakes, volcanoes, floods).**

- o *Addressed in grades 1, 3, and 4.* Explain how people are affected when rivers flood.

**SCIENCE: PSD ESSENTIAL STANDARD 10: SECOND GRADE**

**Earth and Space Science: Weather and Climate:**

**Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space Students know and understand the general characteristics of the atmosphere and fundamental processes of weather (4.2).**

**10.1 BENCHMARK: Sun**

**Students recognize that the Sun is a principal source of Earth's heat and light.**

- o *Addressed in grade 1.* Describe how the temperature and amount of light are different in a sunny and shady place.
- o *Addressed in grades 1 and 3.* Describe how the temperature and amount of light are different in the day and at night.
- o *Addressed in grade 3.* Explain why the temperature and amount of light are different from day to night.
- o *Addressed in grades 1 and 3.* Identify the Sun as the main source of our heat and light.

**10.2 BENCHMARK: Effects of Weather**

**Students recognize how our daily activities are affected by the weather (for example, type of clothing, travel plans, recreational activity).**

- o Describe what to wear outdoors given a specific weather condition. *Also addressed in grades K, 1, 3, and 4.*
- o Identify an outdoor activity that is appropriate for a given weather condition. *Also addressed in grades K, 1, 3, and 4.*

**10.3 BENCHMARK: Observing and Recording Weather**

**Students describe existing weather conditions by collecting and recording weather data (for example, temperature, precipitation, amount of cloud cover).**

- o *Addressed in grades 1 and 3.* Use a table of weather data (temperature, precipitation, cloud cover) to tell what the weather was on a particular day.
- o *Addressed in grades 1 and 3.* Make a bar graph of daily temperature data.
- o *Addressed in grades 1 and 3.* Interpret a bar graph of temperature or precipitation data to identify the weather at a certain time.
- o *Addressed in grade 4.* Describe the weather conditions that are typical of different seasons in Colorado.

**10.4 BENCHMARK: Weather Patterns and Systems**

**Students describe large scale and local weather systems (for example, fronts, air masses, storms).**

- o *Addressed in grades 5, 6, 7, and 8.*

**10.5 BENCHMARK: Influences on Weather Patterns and Systems**

**Students describe and explain factors that may influence weather and climate (for example, proximity to oceans, prevailing winds, and fossil fuel burning, volcanic eruptions).**

- o *Addressed in grades 5, 6, 7, and 8.*

**SCIENCE: PSD ESSENTIAL STANDARD 11: SECOND GRADE**

**Earth and Space Science: Water:**

**Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space Students know major sources of water, its uses, importance, and cyclic patterns of movement through the environment (Colorado 4.3).**

**11.1 BENCHMARK: Water Sources**

**Students identify major sources of water (for example, oceans, glaciers, rivers, groundwater, and atmosphere).**

- o *Addressed in grade 3.* Recognize that water exists in many different places and forms.
- o *Addressed in grade 3.* Distinguish between freshwater and saltwater.
- o *Addressed in grade 3.* Identify fresh water sources (glaciers, lakes, streams, precipitation) and salt water sources (seas, oceans).

**11.2 BENCHMARK: Water States and Forms**

**Students identify and describe the states (solid, liquid, gaseous) in which water can be found on Earth.**

- o Describe ways that ice, snow, and water are the same and ways that they differ. *Also addressed in grade 3.*
- o Identify the state of water present given an example (ocean, air/atmosphere, snow, glacier, stream, lake). *Also addressed in grade 3.*
- o Describe conditions in which water would be found in its various states. *Also addressed in grade 3.*

**11.3 BENCHMARK: Uses of Water**

**Students recognize the importance and uses of water (for example, drinking, washing, irrigating).**

- o *Addressed in grades K, 1, and 3.* Identify water as a basic need of both plants and animals.
- o *Addressed in grade 3.* Identify uses of water in daily activities.
- o *Addressed in grades 3 and 4.* Give examples of how water can affect the surface of the Earth.
- o *Addressed in grades 3 and 4.* Describe a drought and its effects.

**11.4 BENCHMARK: Oceans and Climate**

**Students explain interrelationships between the circulation of oceans and weather and climate.**

- o *Addressed in grades 5, 6, 7, and 8.*



- o *Addressed in grades 3 and 4.* Recognize uses of natural resources (for example, fuels to heat home, plants for home construction, rocks for building roads, land for crops, water to drink).
- o *Addressed in grade 3.* Recognize responsible management of natural resources such as recycling, reusing, trash disposal, and water conservation.
- o *Addressed in grade 3.* Identify some of Earth's natural energy resources such as coal, wind, water, nuclear, oil, geothermal, and solar.

**13.2 BENCHMARK: Problem Solving/Inventing**

**Students invent a device that addresses an everyday problem (or task) and communicating the problem, (or task) design, and solution.**

- o *Addressed in grade 4.* Given a simple everyday problem or task, match it with a scientific or technological solution.

**13.3 BENCHMARK: Conservation**

**Students describe resource-related activities in which they could participate that can benefit their communities (for example recycling, water conservation).**

- o *Addressed in grades K and 3.* Given a common community resource issue, describe an activity that would help solve the issue (for example, waste disposal, recycling, energy availability, energy conservation and efficiency, water availability, and water conservation).

**13.4 BENCHMARK: Careers in Science**

**Students identify careers that use science and technology.**

- o *Addressed in grades 3 and 4.* Given a specific technology, identify a career that makes primary use of that technology.

**SCIENCE: PSD ESSENTIAL STANDARD 14: SECOND GRADE**

**Extended Science Process and Skills:**

**Students understand that science involves a particular way of knowing and understand common connections amount scientific disciplines (Colorado 6).**

**14.1 BENCHMARK: Scientific Repeatability**

**Students recognize that when a science experiment is repeated with the same conditions, the experiment generally works that same way.**

- o Explain why scientists repeat experiments under the same conditions. *Also addressed in grades K, 1, 3, and 4.*

**14.2 BENCHMARK: Scientific Knowledge**

**Students compare knowledge gained from direct experience to knowledge gained indirectly.**

- o Compare their own observations with those reported by others and recognize that both similar and dissimilar evidence helps us learn about the natural world (for example, contributes to scientific knowledge). *Also addressed in grades K, 1, 3, and 4.*
- o Describe how observations/evidence collected by scientists or others who lived long ago (for example, several generations ago) could be used. *Also addressed in grade 4.*

**14.3 BENCHMARK: Patterns and Cycles**

**Students identify observable patterns and changes in their lives and predicting future events based on those patterns.**

- o Recognize that repeating events are the basis of pattern and cycles. *Also addressed in grades K, 1, 3, and 4.*
- o Using an illustration of a natural cycle or pattern, predict one event or stage based on another. *Also addressed in grades K, 1, 3, and 4.*
- o Recognize that parts that make up a cycle or pattern are interrelated. *Also addressed in grades K, 1, 3, and 4.*

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- o Describe how the parts of a cycle or pattern are interrelated. *Also addressed in grades K, 1, 3, and 4.*
- 14.4 BENCHMARK: Simple Systems**  
**Students describe and compare the components and interrelationships of a simple system.**
  - o *Also addressed in grades K, 1, 3, and 4.*
- 14.5 BENCHMARK: Scientific Modeling**  
**Students compare a model with what it represents (for example, map of a school to the actual school).**
  - o *Addressed in grade 4.*
- 14.6 BENCHMARK: Simulation**  
**Students use a model to predict change (for example, computer simulation, stream table).**
  - o *Addressed in grades 5, 6, 7, and 8.*
- 14.7 BENCHMARK: Model Applications**  
**Students will identify and test a model to analyze systems involving change and constancy (for example, math expression for gas behavior, constructing a closed ecosystem such as an aquarium).**
  - o *Addressed in grades 9 and 10.*
- 14.8 BENCHMARK: Mathematical Modeling**  
**Explaining an exponential model (for example, pH scale, population growth, Richter scale).**
  - o *Addressed in grades 9 and 10.*

## APPENDIX B

### Blackline Masters for Curriculum Guide


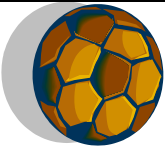
Name\_\_\_\_\_

Date\_\_\_\_\_

## 2.2 Observation Sheet: Living and Nonliving



Center 1

Directions: Write or draw items in Center 1 in the appropriate column.

Living	Nonliving
	

Center 2

Directions: Check the appropriate boxes to determine if the items in column A and B are living or non living.

A	B
<input type="checkbox"/> I breathe <input type="checkbox"/> I eat <input type="checkbox"/> I drink <input type="checkbox"/> I reproduce <input type="checkbox"/> I grow <input type="checkbox"/> I give waste   <input type="checkbox"/> I am living <input type="checkbox"/> I am nonliving	<input type="checkbox"/> I breathe <input type="checkbox"/> I eat <input type="checkbox"/> I drink <input type="checkbox"/> I reproduce <input type="checkbox"/> I grow <input type="checkbox"/> I give waste   <input type="checkbox"/> I am living <input type="checkbox"/> I am nonliving

## Observation Sheet 3.2: Water States

Group Members \_\_\_\_\_

---

1. What do you observe in the cup? What *state of matter* is it in?
  
  
  
  
  
  
  
  
  
  
2. What do you *predict* will happen?
  
  
  
  
  
  
  
  
  
  
3. Draw a picture and explain what happened to the ice. Why did this happen? What *state of matter* is in the cup now?
  
  
  
  
  
  
  
  
  
  
4. Can the water change back into ice? How?
  
  
  
  
  
  
  
  
  
  
5. Can solids and liquids change states?

### Exit Slip 3.2: Water States

Name \_\_\_\_\_

Date \_\_\_\_\_

1. Draw a picture or explain what happened to the water in both cans.

2. What do you think happened to the water in the can.

3. What do you think happened to the water in the sponge?

4. Can liquids turn into a gas?

## Observation Sheet 4.2

Name \_\_\_\_\_

Date \_\_\_\_\_

1. Draw a picture of your rock. Color it the same as your rock.

2. Describe your rock. Is it hard, rough, glassy, smooth, gritty, or chalky?

3. How many paper clips fit around your rock? Draw a picture of your paper clip chain. Draw the same number of paper clips.

4. Weigh your rock. Compare your rock to your classmate's rocks. Are other rocks lighter or heavier than your rock?

Lighter	Heavier

### Exit Slip 4.3: Rock Hunters

Name \_\_\_\_\_

Date \_\_\_\_\_

1. Draw a picture of your favorite rock from this website.
  
  
  
  
  
  
  
  
  
  
2. What type of rock is it?
  
  
  
  
  
  
  
  
  
  
3. What color is it?
  
  
  
  
  
  
  
  
  
  
4. What does it look like?
  
  
  
  
  
  
  
  
  
  
5. How do you think it feels?



## Observation Sheet 4.4: Rock Hunters

Name \_\_\_\_\_

Date \_\_\_\_\_

### Demonstration 1:

1. Draw or describe the sugar crystal:
2. Draw of picture of the solution
3. What do you think will happen to the solution? Why?
4. Draw or describe what happened to the solution.

### Demonstration 2:

1. Draw or describe the salt crystal:
2. Draw of picture of the solution over the rocks.
3. What do you think will happen to the solution? Why?
4. Draw or describe what happened to the solution.

Members of Group \_\_\_\_\_

### Activity Sheet 5.4

Where is it found?	Name	What It Eats	Draw A Picture
Tree			
Grass			
Garden			
Pond			
In Your House			

## APPENDIX C

### Science Rubrics

## Science: Constructed Response Rubric

	Level of Understanding	Use of Accurate Scientific Terminology	Use of Supporting Details	Synthesis of Information	Application of Information*
<b>4</b>	There is evidence in the response that the student has a full and complete understanding.	The use of accurate scientific terminology enhances the response.	Pertinent and complete supporting details demonstrate an integration of ideas.	The response reflects a complete synthesis of information.	An effective application of the concept to a practical problem or real-world situation reveals an insight into scientific principles.
<b>3</b>	There is evidence in the response that the student has a good understanding.	The use of accurate scientific terminology strengthens the response.	The supporting details are generally complete.	The response reflects some synthesis of information.	The concept has been applied to a practical problem or real-world situation.
<b>2</b>	There is evidence in the response that the student has a basic understanding.	The use of accurate scientific terminology may be present in the response.	The supporting details are adequate.	The response provides little or no synthesis of information.	The application of the concept to a practical problem or real-world situation is inadequate.
<b>1</b>	There is evidence in the response that the student has some understanding.	The use of accurate scientific terminology is not present in the response.	The supporting details are only minimally effective.	The response addresses the question.	The application, if attempted, is irrelevant.
<b>0</b>	The student has <b>NO UNDERSTANDING</b> of the question or problem. The response is completely incorrect or irrelevant.				

## Science Project Rubric: Insects

Excellent	<ul style="list-style-type: none"> <li>• Neat and student has obviously spent time preparing.</li> <li>• Turned in on time.</li> <li>• Student applies observations and discussions of insects and their habitats to project.</li> <li>• The student has full and complete understanding of insects and their habitats.</li> </ul>
Satisfactory	<ul style="list-style-type: none"> <li>• Student has spent an adequate time preparing project.</li> <li>• Turned in on time.</li> <li>• Student has applied most of what has been observed and discussed in class to their project.</li> <li>• The student has a good understanding of insects and their habitats.</li> </ul>
Needs Improvement	<ul style="list-style-type: none"> <li>• Project looks “rushed”</li> <li>• Project is late.</li> <li>• Student has related few ideas from observations and discussions to their project.</li> <li>• The student has some understanding of insects and their habitats.</li> </ul>
Unsatisfactory	<ul style="list-style-type: none"> <li>• Project is inexcusably late and/or “sloppy”.</li> <li>• Student has not applied ideas from observations and discussions to their project.</li> <li>• The student has no understanding of insects and their habitats.</li> </ul>

APPENDIX D

Teacher Resources

## TEACHER RESOURCES

### *Children's Books:*

- Baldwin, C. (2006). *Material matters: States of matter*. Chicago: Raintree.
- Berenstain, S. & Berenstain, J. (1977). *The Berenstain Bears' science fair*. New York: Random House.
- Berger, M. & Berger, G. (1999). *How do flies walk upside down? Questions and Answers about insects*. New York: Scholastic.
- Bingham C. (2004). *Rocks and minerals*. New York: Dorling Kondersley.
- Bunting, E. (1999). *Butterfly House*. New York: Scholastic.
- Burke, M. B. (2001). *A butterfly's life*. New York: Steck-Vaughn.
- Carle, E. (1981). *The very hungry caterpillar*. New York: Scholastic
- Fleischmann, P. (1988). *Joyful noise: Poems for two voices*. New York: Harper and Row.
- Florian, D. (1998). *Insectopedia: Poems and paintings*. San Diego: Harcourt Brace.
- Froman, N. (2001). *What's that bug? Everyday insects and their really cool cousins*. Boston: Little & Brown
- Frost, H. (2001). *Water Bugs*. Mankato, MN: Pebble Books.
- Geisel, T. S. (1949). *Bartholomew and the oobleck*. New York: Random House.
- Hewitt, S. *Solid, liquid, or gas?* New York: Children's Press.
- London, J. (1997). *Puddles*. New York: Viking.
- Ontario Science Centre. (1998). *Solids, liquids, and gases*. Toronto: Kids Can Press.
- Oxlade, C. (2002). *States of Matter*. Chicago: Heinemann Library.
- Rabe, T. (1999). *On beyond bugs! All about insects*. New York: Random House.
- Rockwell, A. F. (2001). *Bugs are insects*. New York: HarperCollins.

Rosinsky, N. M. (2003). *Rocks: Hard, soft, smooth, and rough*. Minneapolis: Picture Window Books.

Scarborough, S. (1998). *About Bugs*. Redwood City, CA: Treasure Bay.

Schwartz, D. M. (1999). *Life cycles: Monarch butterfly*. Huntington Beach CA: Creative Teaching Press.

Stewart, M. (2002). *Rocks and minerals: Crystals*. Chicago: Heinemann Library.

Tocci, S. (2002). *Experiments with rocks and minerals*. New York: Children's Press.

Williams, M. (1985). *The velveteen rabbit*. New York: Random House.

#### *Teacher's Books:*

Koch, J. (2002). *Science stories: A science methods book for elementary school teachers*. New York: Random House.

National Wildlife Federation. (1999). *Ranger Rick's nature scope: Incredible insects*. Philadelphia: Chelsea House.

#### *Websites:*

Biobugs. (2006). <http://www.bugbios.com/entophiles.C>

Center for Advancing Student Technology (CAST). (2006). UDL Toolkits.  
<http://www.cast.org/teachingeverystudent>.

Chicago Children's Museum Website. (2006)  
[http://www.childrensmuseum.org/buildabug\\_real.html](http://www.childrensmuseum.org/buildabug_real.html)

Enchanted Learning at <http://www.enchantedlearning.com>

Nature Gift Store at <http://www.nature-gifts.com>

Pest Worlds website at <http://www.pestworldforkids.org/archibald/index.html>.

Science Netlinks. (2006). <http://www.sciencelinks.com>

Virginia Tech Department of Entomology. (1998).  
<http://www.enta.vt.edu/~sharov/3dvirtual.html>.